SCIENCE

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CONSTRUCTIVE COMMUNITY AND PERSONAL HYGIENE[1]

I. THE COMMUNITY

THE need of constructive work in medicine applies to the community as well as to the individual. The steady growth of American cities—in fact, of the cities of the world—indicates that we are to become in the not far distant future predominantly a city people. The accompanying diagram (*A*) shows how the rural population has been steadily falling and the urban population steadily rising since 1880 in all five census divisions of the United States. In Massachusetts, during the same period, there has been an absolute decrease of some thirty thousand in the rural population, while the urban population has increased by over one million. This is shown in graphic form in diagram *B*. The remarkable growth of the cities appears more graphically still in the diagram (*C*) showing the growth in the urban proportion of the population during the past eleven decades.

The causes of this steady urbanization of our kind are not far to seek. Three sets of causes may be read by him who runs. First is the *economic* cause. Owing to the use of machinery, an ever smaller fraction of our people can be engaged in the production of enough raw material to supply the needs of the world. To produce more than this is to invite economic disaster. Hence a progressively large fraction of the people will be engaged in

[1] An address delivered at the College of Physicians and Surgeons, New York City, April 14, 1909, in the course of Columbia University lectures on sanitary science and public health.

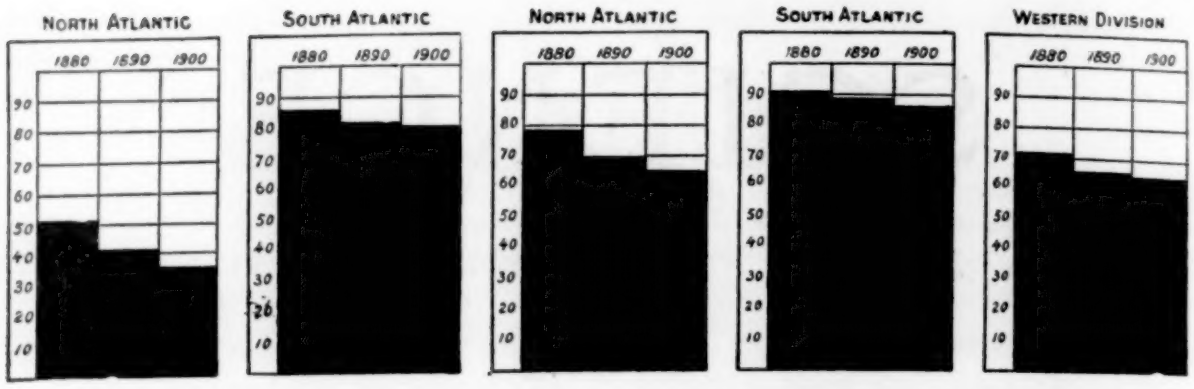

Fig. A. Diagrams showing the increase in the per cent. of urban population and the decrease in the per cent. of rural population in the five census divisions of the country from the census of 1880 to that of 1900. The portion in outline represents the urban population and that in black the rural population in each case.

the elaboration of this raw material. This means cooperation, and cooperation means in the main community life.

Second, *social*. We are primarily social in our interests, and in the main like to live near enough together to enjoy each other's society. The chief rewards and the chief penalties of society are social in their nature. The severest penalty is that of solitary confinement, and the greatest joys are those which are associated with friendship.

Third, *cooperation*. By means of cooperation we can secure for ourselves comforts and pleasures of many kinds which it is quite impossible for the individual family to secure for itself.

The fact of this progressive urbanization would justify a most dismal outlook for the future of the world, did the prevailing opinions regarding the nature of city and country life represent the actual facts in the case. I can not better indicate the present status of public opinion, and even of expert scientific opinion, than by quoting Theodore Roosevelt and the eminent Dr. Ogle. Theodore Roosevelt in *The Outlook* under date of April 19 says:

> The men and women on the farms stand for what is fundamentally best and most needed in our American life. Upon the development of country life rests ultimately our ability . . . to supply the city with fresh blood, clean bodies and clear brains that can endure the terrible strains of modern life; we need the development of men in the open country, who will be in the future, as in the past, the stay and strength of the nation in time of war, and its guiding and controlling spirit in time of peace.

Dr. Ogle characterizes the city as "a mighty vampire, continually sucking the strongest blood of the county to keep up the abnormal supply of energy it has to give out in the excitement of a too fast and unwholesome life."

There is, however, another point of view, another set of facts, which I believe warrants a readjustment of opinion. Let us look at the death rate, that measure of vitality in which is summed up all of the influences that bear upon human life. Here is a diagram (*D*) which shows clearly the changing character of the death rate in the city and in the country.

An analysis of this set of figures is quite beyond the possibility of presentation in a brief argument; but although the problem is complex, there seem to be clear indications that the death rates in cities are lowering; that infant mortality, particularly in cities, is becoming less serious; and that in many cases [city] death rates and infant mortality are lowering at a

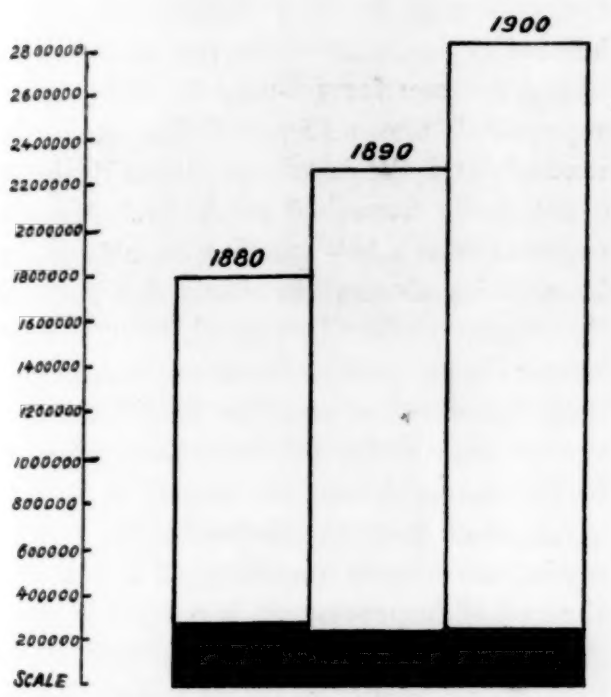

FIG. B. Urban and rural population in Massachusetts as shown by the censuses of 1880, 1890 and 1900. Urban population in outline and rural in black.

more rapid rate in urban communities than in rural districts.

Let us turn now from this statistical consideration to certain facts of general knowledge and observation which indicate

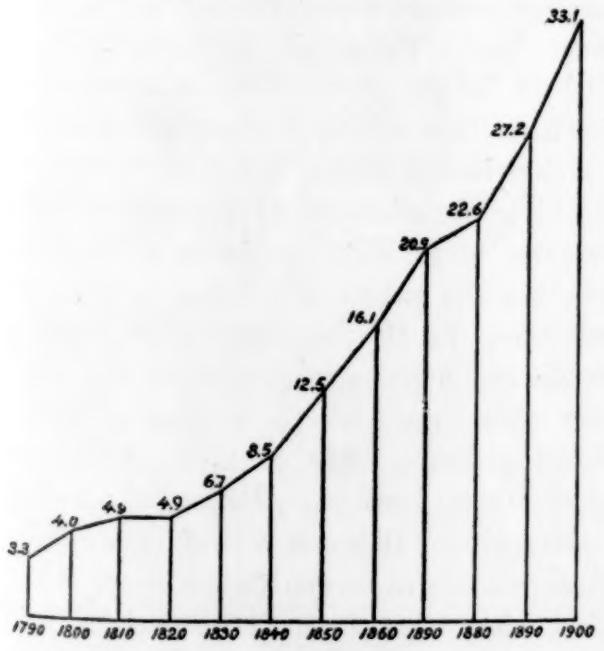

FIG. C. Diagram showing the increases in the per cent. of urban population in United States from 1790 to 1900.

not merely that we are gradually being forced to live together and are suffering thereby, but that we are learning to live together with increasing success and in some cases have already accomplished a result which places city life not only on a par with country life in healthfulness, but superior to it.

Water supply and sewage disposal are fundamental elements of wholesome living. In the very early days when the water supply was taken from pools or

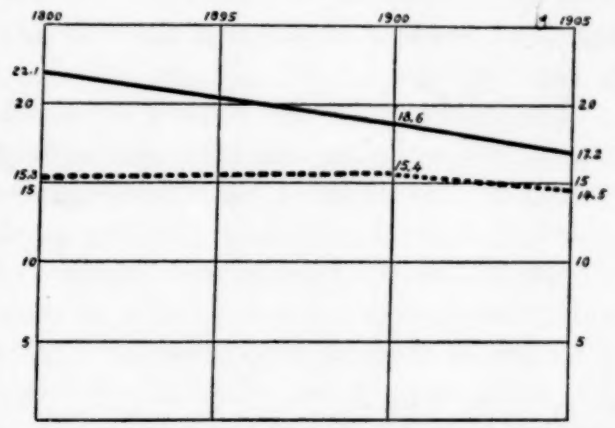

FIG. D. Diagram showing the death rates in registration states from 1890 to 1905. The solid line represents the urban rate and the dotted line the rural rate. Note that the death rate is falling much more rapidly in the cities than in the country.

running streams, and when human waste was either thrown on the land or into the water, it was necessary for families to live at considerable distances from each other if they were to be safe from disease; and even then there was a large degree of sickness in the individual family, due to the family waste. The location of privies in relation to wells has been so thoroughly exploited as to only need mention. Gradually we have come to live closer and closer together. To-day in our well-administered cities we have better conditions on the average than formerly obtained in the country, with respect to these two things. Our city water supply is safer than that of country districts, which is

drawn from streams and pools. This statement is true even when we compare the present city conditions with the country when it was sparsely settled and when the family lived quite by itself. The same is to be said in regard to the disposal of sewage. That is, these are purely mechanical problems which have been solved by our sanitary engineers. By using water from a good city water supply we are in less danger of contracting disease than in using country water; we are in less danger from the pollution and contagion resulting from sewage in the city than we are in the country.

This is not the only respect in which preventive medicine has been not merely remedying the evils of close dwelling together, but making them a positive good. It would take an extensive survey of widely connected groups of facts to show the relation of food supply in the city to the food supply on the old, isolated country farm. I do not think it is open to the danger of much serious criticism to say that the food supply available in our cities is more varied and better suited to support life and to make eating a pleasure, than it is in the country. The day of the all-round country farm has nearly disappeared. Those who come to the farms in summer find that the farms are to a considerable extent dependent upon the same sources of food supply as are the cities. It is not a fact that many of our farms have regular supplies of fresh vegetables to be consumed during the various seasons of the year. This is far less true in the city, where the food supply is made up of products drawn from various parts of the country and other parts of the world. By living together in communities we are able to have fresh meat regularly; this is rarely the case on the farm. I do not think it is too much to say that the milk supply of a modern, well-regulated city is better than the milk supply of the average farm where the dairy is unsupervised, the udders of the cattle unwashed, and the hands of the milkman in a not easily described condition. My own experience as a boy working on a farm and in a dairy forms the basis for some of these judgments. In regard, then, to milk, butter, eggs, meat, fresh vegetables and fish—those of us who live in cities are on the average better off than those who live in the country, who are largely dependent upon what they themselves raise. These, again, are largely problems of health, and the end of improvement is not yet in sight.

The chief objections made against the massing of people in cities, and indeed of city life itself, are that the city does away with privacy; that it creates dirt, darkness and bad ventilation in our dwellings; that recreation is unwholesome; and, in general, that the pace of life is too fast. The science of medicine has a profound bearing upon these problems. Let us consider first the problem of ventilation. The most extreme conditions of artificial ventilation are those which the submarine diver must face. Fresh air is forced to him. The air he breathes can be and is kept as fresh as that which is breathed by those who are in the open. It is true that people working out-of-doors in country districts breathe good air. It is very doubtful whether the habits of country people with reference to the ventilation of sleeping rooms are such as to give them any manifest advantage over the rest of us during sleeping hours. The problem of securing good air is purely a problem of sanitary engineering. It is not a problem of space. It is possible to so ventilate a room of any dimensions that it shall be entirely suitable as a place for working or sleeping. The tenement as such does not render it

necessary that the rooms shall be ill-ventilated. It is possible to have large numbers of small rooms, adequately and automatically ventilated. The air can be kept free from dust and at suitable temperatures, having at the same time the proper amount of humidity.

The problem of dirt is a similar one. The cleanliness of a room does not depend upon its size. The rooms of a tenement may be kept as clean as those in a well-administered office or even hospital building. It is a problem of adequate care, not a problem of congestion. Because a building is situated in the country is no evidence that it is cleaner than a building situated in the city.

The same problem presents itself regarding darkness. It is true that there are in the city many tenements with dark rooms. It is not true that this condition is necessary. Tenements with light rooms are now being built. We do not yet know to any full extent the character and effect of natural and artificial light upon human life. Important and interesting investigations have been made with reference to the effect of artificial light upon the growth of plants. We may discover that natural light is not necessary to any such extent as is at present believed. We do not know the possibilities even from the hygienic standpoint of indirect artificial lighting. The problem awaits the investigations of the sanitary engineer and physician.

The problem of privacy is the problem of the expensiveness of space in the city. Because we are dependent upon natural ventilation and natural lighting, and because we have in the main patterned our dwellings after those which evolved under conditions of rural life, all our feelings are to the effect that large rooms are better than small rooms. With the building of comparatively large rooms and the influx of larger numbers of inhabitants than was expected, there has developed the vicious habit of having a number of persons inhabit the same room. This condition can be partly met by the use of smaller rooms and forced ventilation.

The evolution of the city kitchen is one of the straws which shows the direction of present practise. Some years ago in building a house, the plan was altered so as to enable us to have a larger kitchen. We now see that this was due to a mistaken notion which has come down to us from the time when the kitchen was the center of the family life, when food was eaten in the place in which it was cooked, and the partaking of food together was a symbol of friendship. This larger kitchen proved a nuisance, for it involved too much walking from one part of the room to the other. The modern apartment house kitchen, which is exceedingly small, filled with space- and time-saving devices, is easily kept clean, is more convenient, permits more rapid operation, and is in every way better than the old style kitchen.

We do not yet know the feasible and even desirable limitations of space for various social and family uses. The disappearance of the trades from the home, the development of outside institutions as places for social life, and other changes have altered the basic space necessities of domestic life; but the traditions of the former conditions remain.

This whole group of problems needs to be attacked by the social worker who is equipped with the tools of sanitary science. The great work of constructive medicine or "biological engineering" consists not in the futile effort to turn back the hands of the clock which marks human progress, in the attempt to restore rural conditions, but in the study of the specific

conditions that are presented, in order that our cities may be more healthful abodes than human kind has as yet possessed.

Large steps in this direction have already been taken, quite aside from the fundamental ones of securing a varied food supply, good water and ventilation, adequate disposal of sewage; doing away with dirt and darkness, and the conserving of privacy, which have already been mentioned. We are awakening to the fact that there is a large group of elements in the situation which can only be attacked by the community as a whole. There are problems before which the individual family is helpless. I refer to such matters as the provision of adequate open air spaces for parks and playgrounds, places where wholesome social life may be carried on. We have already begun to realize that the average homes of our large cities are inadequate as social centers. We have watched with dismay the development of the saloon as a place where men may come together for social purposes; the dance hall, connected with the saloon, where young people come together and dance—a form of recreation which in itself is thoroughly wholesome, but which under prevailing conditions is a menace to both young men and young women. We need places where the children can play freely and in a wholesome way, without being imperilled by or hindering the traffic of the streets. We have in our municipalities ordinances against children playing in the streets, and this is right. We are commencing to take the steps which should go with the enactment of such laws, that is, steps for the provision of places where children can play. The open spaces are being increasingly built up or fenced in.

It was not many years ago that the city of Boston instituted its first public playground. In 1908 the state of Massachusetts passed a law which requires every city and town of ten thousand inhabitants and over to vote upon the question as to whether they shall have playgrounds purchased, equipped and maintained out of public taxes. Forty-two of these cities and towns voted during the following fall and winter. Of this number forty voted in the affirmative and two in the negative. The total vote cast in the affirmative was 154,495; the total vote in the negative was 33,886. Thus that state in the United States which is the least inclined perhaps of any toward socialism, which has had the most experience with playgrounds, has declared in a way that is almost unparalleled in the history of the referendum, that the city itself must provide not only places for children to play in, but competent leadership in those plays and games which shall make for wholesome physical and moral development.

Massachusetts does not stand alone. In 1907 there were ninety cities in America that were maintaining children's playgrounds supported at least partly by public taxation. The number has increased since that time, so that in 1909 there were upwards of 336, while over 118 additional communities are now taking steps toward the development of playgrounds or playground systems. The city of Philadelphia, not content with its exceedingly active but sporadic work, has recently appropriated five thousand dollars for a preliminary investigation as to the needs of the young people of the community concerning matters of recreation, and for the presentation of a policy and plan for the future development of recreation in the city. New York city, while it has not proceeded as far as to make any general plan for the development of the city and the provision for its needs, has already spent over eleven million dollars on children's play-

grounds, while Chicago has spent fifteen million dollars on a system of public playgrounds. I am told that the indirect expenditure upon these Chicago playgrounds runs upwards of forty millions.

These are all problems in community hygiene. Their initiative and direction depend upon the technical expert, who shall be trained in a way that is not yet possible in any school in America. The old forms of athletic exercise are no longer suited to the conditions of large schools with limited playgrounds. We need men who are trained with reference to the needs of the growing organism, who have intimate acquaintance with the nature of boys' instinct feelings, who will devise types and forms of athletics which will embrace the great mass of boys instead of the favored few that are brought forward under the conditions of interscholastic athletics which obtain at present.

The cities with their elaborate water supply are able to make provision for public baths in a way impossible in the country. Unlike the great European cities, the municipalities of the United States had done practically nothing for public baths before 1890. Since the agitation started at that time by Dr. Simon Baruch, a great deal has been done, though we are still far behind the other nations, owing in part to the common though quite erroneous impression that the majority of people have access to private baths. In 1904 the National Bureau of Labor published a comprehensive account of the public baths then existing in the United States, with a showing of thirty-seven municipalities, providing bathing facilities in a wide range of number and efficiency. There is no uniformity in the legal provision for baths. Massachusetts has had a permissive law since 1874, and New York a mandatory law since 1895, for cities of 50,000 and over. The control of the baths is variously exercised by the departments of public buildings, of parks, of education, etc. Though school baths are not compulsory, as in many European cities, they are a growing factor in the educational systems. The character of the baths provided is rapidly changing; the floating baths are becoming impracticable on account of the difficulty of keeping the water near large cities uncontaminated; tub baths are nearly out of use, while shower or rain baths are universal, being superior in cleanliness, ease of administration and economy. A few favored localities have swimming tanks. The baths are mostly free, though a few places charge for soap and towels.

As in our other public institutions, the psychological and social elements in the public baths are increasingly being recognized, so that with their growing attractiveness in form, there is also development in function. Thus in the latest buildings, gymnasiums, playgrounds and rest rooms are provided for comfort and recreation, while well-equipped laundries shorten the hours of labor for the women and at the same time form a natural social gathering place, like the old time village washing pool. The field houses of Chicago and other places give promise of meeting some such need as was met by the Greek palæstra and the Roman baths.

To mention a single instance, New York city at the present time has eight interior baths, and supports fifteen floating baths in summer. In 1902, a committee appointed by the Association for Improving the Condition of the Poor estimated that at least seventeen interior baths were needed in Manhattan alone. The eight baths now in operation vary in capacity and elaborateness from 154 showers and two large swimming tanks to eighty show-

ers. Two others are to be opened shortly and there is provision for four others. In 1908 the total attendance was 4,921,718, of which the Rivington and Centre Street baths counted 1,942,657, though the facilities there are less than in the others. There are a few schools provided with showers, and the Department of Parks maintains a few. Brooklyn has five interior baths and provision for two others, and seven floating baths. There are about a score of privately maintained free baths in New York and Brooklyn.

II. THE INDIVIDUAL

This need of constructive or preventive medicine as related to the community is no less important than its relation to the individual. It is not enough for the individual to have his disease cured, prevented, or even to render him immune. Something more is needed. Perhaps the case can be made clearer by an individual instance.

A young man, aged twenty-nine, came to a physician for advice. He had broken down from so-called "overwork." Successive visits to excellent sanitaria had put him on his feet temporarily, but when going back to his regular conditions of work and living, he again succumbed to them. A careful examination failed to indicate any particular pathological conditions demanding treatment, excepting those that are usually associated with consecutive fatigue. His heredity was excellent. The cardiac, pulmonary, digestive and excretory organs seemed to be normal, in both structure and function. Blood pressure was fair; the arteries were soft and elastic; reflexes were normal. But he was unable to think consecutively, or even to write a brief personal note, without producing mental confusion. In writing he was constantly obliged to refer to the first part of his sentence to see what he had said. In conversation he would frequently forget entirely all that had preceded and would have to be reminded of the subject. His history showed that his habits of work were injudicious. He had become so completely absorbed in his work as to keep it before him during meal times; he would take it home with him, carry it on Sundays and holidays. The problem consisted not merely or mainly in inducing him to take such steps as would lead to a recovery from the fatigue, but in discovering those habits of life under which he would work most effectively; in discovering what hours of labor would produce the best results; what kind and quantity of recreation, as well as intellectual interests, he should cultivate; and discovering how under his particular conditions it was possible for him to establish and maintain these habits.

A course of ordinary sanitarium treatment was established at first, his physician being daily, and at times almost constantly with him, for at this period it was not possible for him to develop sufficient initiative to carry out the details of his prescribed activities. He was given gentle, outdoor exercise for considerable and definite periods each day. His dietary was studied with reference to his own idiosyncrasies which were rather definite, but which up to that time were unknown to himself. As he recovered from his fatigue, he was given courses in reading, at first fifteen minutes twice a day. It was reading of a kind that involved definite attention and logical thought, but of a character wholly different from that required by his regular occupation. At the end of three months he was in a normal condition; but if he had been allowed to return to his work at that time, he would have been in the same condition as he had

been after previous experiences in sanitaria.

Consequently he was allowed to resume his professional work in progressive doses. At first he was allowed to work an hour per day. With increasing strength and adjustment the amount was steadily increased, until he was doing as much work per day as he had ever done, but was doing it in fewer hours. He had established other intellectual interests. He had learned how to play, had learned the fundamental necessity of attention to the essentials of good living, namely regular and wholesome eating, sleeping, exercise, etc. He was kept under observation for about six months. This happened eighteen years ago; he has carried his work successfully ever since.

This case is mentioned, not because it is exceptional, but because it is not exceptional. People do not know how to live. This man needed, as most people do need, the help of the physician—not only in times of disease, to aid in recovery, not only that they may be preserved from accident, contagion and other sources of disability. People need to be taught how to administer their time so as to live wholesomely and effectively, how to live so that life shall be a joy and not a burden, how to use their leisure time so that it may contribute to strength rather than to exhaustion through dissipation—how to manage efficiently the machinery of life. This is the problem of the biological engineer.

Let me mention another case. It is that of a man who died recently at the age of forty-seven. The immediate cause of death was cerebral hemorrhage, due to arterial sclerosis, with its usual degenerative conditions of the kidneys. There appeared to be no adequate reason for the loss of this man to himself, to his family, to his community, excepting that he did not know how to live. He was unwise in his eating, unwise in his manner of work. He did not know the significance of recreation, nor did he know the particular idiosyncrasies of his personal makeup.

We are told that every man is a fool or his own physician at forty. But the human organism is too complex to permit of adequate self-knowledge gained merely through common sense and personal experience. To this must be added that wisdom which can only come from the study of large numbers of cases and the putting together of extensive experiences. It is a conservative statement to say that the average efficiency and happiness of American men and women could be doubled by judicious attention to these matters of health. I do not mean merely the rigid observance of general rules of hygienic living. I mean specifically that conduct which is based upon an expert knowledge of the individual's peculiarities, and of the environment under which he is living and must work.

This study of individual differences, of individual environment, is one which gives scope to the largest powers and gives rewards of the highest character. We all know that it is foolish to tell the overworked bank clerk that he must take a vacation, go off to Florida or Europe for six months, when he is without financial resources. It is foolish to tell an engineer who is in the middle of a large piece of work that he must stop and take a vacation. It is necessary for him to complete his work. The problem is to find out how that particular man, with his particular makeup, under the particular environment in which he lives, may so conduct himself as to get the maximum of life, efficiency and happiness out of himself.

It is a problem of discovering the kind of habits that the individual ought to

form, of finding out how he can form those habits, and then standing by him until the habits are formed and the new life fairly on its way. It is not enough for us that we shall be protected from the contagion of smallpox, that we shall not be inoculated with the plague, that we shall not have our water supply contaminated with the typhoid bacillus. It is not enough even that the tissues of our bodies shall be highly resistant to various diseases. There is the great positive constructive side which relates to life's habits that needs attention, and without such attention the individual is helpless in securing for himself that high degree of efficiency which every skilled engineer demands from a good piece of machinery.

This phase of medical practise is gradually coming to be recognized by the laity and is being met by the profession. It is obvious that equipment for such practise involves, as does every other medical specialty, the classic studies of the regular medical curriculum. This specialty also, like every other specialty, demands its own kind of aptitude, as well as that specialization in study and experience which belongs to a specialty. It consists essentially in bringing medical science to bear upon the whole life of the patient, so that it may be raised and kept on the highest attainable level of efficiency and wholesomeness.

III. CONCLUSION

This is not the place to discuss other great problems that are incident to the life of the city or to that of the individual. I have tried merely to show that community life is of necessity increasing; that the conditions that are deleterious to health can be and are being met; that the prospect is already clearly in view that urban conditions will be more favorable to human life than rural conditions; that the desire of our kind to live in close relations can be gratified with a gain, instead of a loss of human life and vitality.

It is not enough that medical science shall be increasingly successful in combating and curing disease by means of drugs, surgery, suggestion and hygienic measures. It is not enough that the great sources of disease shall be eliminated by providing freedom from contagion and infection through uncontaminated water, pure food, fresh air. It is not enough that by means of these or other measures we shall be rendered immune to any or even all diseases. It is not enough that we look forward with firm confidence to the control of tuberculosis, and even pneumonia, cancer and arteriosclerosis.

The science of medicine needs and is developing groups of specialists who are raising the efficiency of individuals by discovering the precise ways in which those individuals, with their particular constitutions, may best live in their particular environment. There are also developing other groups that are solving the problems of how human kind shall live in the new and glorious era that we are so fast entering, the era of living together, the era of the city.

Luther Halsey Gulick

THE RESEARCH LABORATORY OF PHYSICAL CHEMISTRY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

During the past year thirteen men, including four candidates for the Ph.D. degree, have been working in this laboratory upon researches in theoretical and physical chemistry.

One of the main lines of work is the continuation of the research upon the properties of salt solutions in relation to the Ionic Theory, which, with the view of developing that theory, has been carried on for a number of years under the direction of Professor A.

A. Noyes. The special subjects at present under investigation are: (1) the transference numbers of tri-ionic salts by Dr. K. G. Falk, with the purpose of determining whether intermediate ions, such as KSO_4^- or $PbNO_3^+$, exist in considerable quantity; (2) the electrical conductivity of mixtures of salts, by Mr. A. C. Melcher, Dr. W. C. Bray and Mr. F. L. Hunt, with the purpose of establishing the general law governing the ionization of salts; and (3) the solubility of salts in the presence of other salts, by Dr. W. D. Harkins, with the purpose of determining empirically the form of the law of solubility effect which must be substituted for the inexact mass-action form of that law. This line of research has again been aided on the financial side by a grant of $3,000 made to Professor A. A. Noyes by the Carnegie Institution of Washington.

Another of the main lines of research in the laboratory, which is being carried out by graduate students under the direction of Professor G. N. Lewis, is the experimental determination and computation of a system of values for the free energy of chemical substances analogous to the system of values for the total energy previously developed by thermochemical investigators. The problem is one of fundamental importance to the science of chemistry, since from the free-energy data for the substances the equilibrium of the chemical reactions in which they are involved can be computed. The special reactions now being studied in this direction are: (1) that between sulphur and water, producing sulphur dioxide and hydrogen sulphide, by Mr. Merle Randall; (2) that between nitric oxide, nitric acid and water, producing nitrous acids, by Mr. Arthur Edgar; and (3) that between chlorine gas and chlorine-ion in aqueous solution, which is being studied by electromotive force measurements by Mr. F. F. Rupert.

Dr. W. C. Bray has continued the studies of the equilibrium of some chemical reactions begun a few years ago in this laboratory by Mr. G. M. J. Mackay; namely of those between solid cuprous iodide, iodide and cupric iodide in solution, between potassium iodide and polyiodide in solution and between iodine and water.

During the past year articles describing theoretical studies upon the newly developed principle of relativity have been published by Professor G. N. Lewis and by Mr. R. C. Tolman; and an article upon the quantitative application of the theory of indicators to volumetric analysis has been prepared by Professor A. A. Noyes. An experimental study of indicators from this standpoint has been undertaken by Professor M. S. Sherrill.

SCIENTIFIC NOTES AND NEWS

PROFESSOR GEORGE DAVIDSON, of the University of California, eminent for his contributions to astronomy, geography, navigation and geodesy, celebrated, on May 9, his eighty-fifth birthday.

COMMANDER ROBERT E. PEARY lectured before the Imperial Geographical Society of Vienna, on May 18, and was presented with the gold medal of the society.

PROFESSOR WALTER NERNST, professor of physical chemistry at Berlin, has been elected an honorary member of the Manchester Literary and Philosophical Society.

IT is stated in *Nature* that the council of the Institution of Civil Engineers has made the following awards for papers during the session 1909–10: a Telford gold medal to Mr. C. M. Jacobs (New York); a Watt gold medal to Mr. J. D. Watson (Birmingham); a George Stephenson gold medal to Mr. D. A. Matheson (Glasgow); Telford premiums to Messrs. F. C. Buscarlet (Sunderland), A. Hunter (Glasgow), I. C. Barling (Tynemouth), J. Dalziel and J. Sayers (Derby), and J. Shaw (Birkenhead), and the Manby premium to the late Mr. C. W. Hodson (London).

ONE of the Carnegie research scholarships of the Iron and Steel Institute, London, has been awarded to Professor Paul Gorens, of the Royal Technical College, of Aix-la-Chapelle, for a study of the properties of cold-hardened iron and steel.

Professor J. S. Kingsley sails for Italy and the Zoological Congress on May 28. All matter intended for the *Journal of Morphology* should be sent direct to the Wistar Institute until his return in September.

From Oxford University Dr. G. C. Bourne, Linacre professor of comparative anatomy and Mr. E. S. Goodrich, fellow of Merton College, have been appointed representatives at the International Congress of Zoology.

The Academy of Natural Sciences of Philadelphia has appointed as delegates Dr. Richard A. K. Penrose and Dr. Edgar T. Wherry to represent it at the eleventh International Geological Congress and Dr. Henry Skinner to represent it at the first International Congress of Entomology.

We learn from *Nature* that Dr. and Mrs. Seligmann have returned from their first exploratory ethnological survey of the Anglo-Egyptian Sudan, to which they were appointed by the Anglo-Egyptian government. They studied the hitherto uninvestigated Nubas of southern Kordofan, and the Shilluks, Dinkas and Shir of the White Nile. A short time was spent between the White and Blue Niles, where a Neolithic site was discovered. Observations were made on the sociology and religion of various tribes, and some anthropometrical data were obtained, especially of the Nubas.

Professor John R. Allen, of the University of Michigan, has been given leave of absence to go to Constantinople and assist the president of Robert College in laying out a course in engineering and to install an electric lighting system for that college. Professor Allen expects to visit a number of European schools of engineering.

Dr. F. W. Andrewes will deliver the Croonian lectures before the Royal College of Physicians of London in June. The Harveian oration will be delivered by Dr. H. B. Donkin on October 18. The Bradshaw lecture by Dr. G. N. Pitt; the FitzPatrick lectures, on "The History of Medicine," by Sir T. Clifford Allbutt and the Horace Dobell lecture, by Dr. W. Bulloch, will be delivered in November.

Dr. Leon J. Cole, recently appointed to the chair of experimental breeding at the University of Wisconsin, has begun his work. He has made arrangements to conduct breeding operations with small birds and mammals, such as will reproduce rapidly and will be inexpensive to maintain. He will also begin the collection of data as to the heredity of characteristics in farm animals. Work with plants will be begun later.

It is proposed to add to the collection of portraits of deceased members of the American Philosophical Society, that of its first president, Thomas Hopkinson (1743).

A memorial service for Dr. Harold Taylor Ricketts, associate professor of pathology at the University of Chicago, who died of typhus fever in Mexico City on May 3, was held at the university in Leon Mandel Assembly Hall, on Sunday, May 15. His fatal illness was contracted as the direct result of an investigation of the disease which he had been pursuing for several months. President Henry Pratt Judson made an address on the work of Dr. Ricketts, and the essential facts of his life and death were given by Dr. Russell M. Wilder, who was associated with him in his work in Mexico. Dr. Ludvig Hektoen delivered an address on the personality of Dr. Ricketts and the nature and value of the work. Professor Charles Henderson spoke on the humanitarian aspects of Dr. Rickett's work and his death.

On convocation day on June 14 at the University of Chicago will be laid the cornerstone of the library building which is being erected as a memorial to the university's first president, William Rainey Harper. The address will be delivered by Mr. Clement Andrews, librarian of the Crerar Library of Chicago, formerly instructor in chemistry at the Massachusetts Institute of Technology.

The council of the Royal Astronomical Society has adopted the following address in memory of Sir William Huggins:

The council have learned with the deepest regret of the death of Sir William Huggins, and desire to record their sense of the great loss which the society itself and science in general have thus

sustained. As fellow of the society since 1854, as a member of the council since 1864, as secretary in 1867–72, as foreign secretary in 1873–75, as president in 1876–78, and as foreign secretary from 1883 to the present time, he rendered services of the greatest value to our society. His wide knowledge and sound judgment were ever at its disposal. But it is on the higher ground of his having been the pioneer in all those branches of research now termed astrophysics that he has the greatest claim to respect and admiration. The council, in requesting the president to convey their sympathy to Lady Huggins on her bereavement, desire him to say how much they have reason to be proud and thankful for the noble life's work of her husband, with whom she has actively collaborated for so many years.

DR. ZENCHALLO, medical officer of the International Sanitary Commission, has died of plague at Jeddah as the result of infection when examining rats.

STANISLAU CANNIZZARO, the eminent Italian chemist, professor in the University of Rome and a member of the Italian senate, died on May 10, at the age of eighty-four years.

MR. JAMES CANTLIE, hon. secretary of the Pellagra Commission, has received, as we learn from the London *Times*, the following telegram from Dr. Sambon, dated Rome, May 13: "The pellagra field commission has definitely proved that maize is not the cause of Pellagra. The parasitic conveyer is the *Simulium reptans*."

AN International Association of Colonial Agriculture was founded in 1905 at the close of the first International Congress of Tropical Agriculture, held in Paris in that year. The association has arranged to hold a second International Congress at Brussels on May 20–23.

THE Society for the Promotion of Engineering Education is to meet at the University of Wisconsin, June 23–25.

THE Royal College of Physicians of London announces that the next award of the Weber-Parkes prize of 150 guineas and a silver medal will be made in 1912, the subject of the essay to be "The Influence of Mixed and Secondary Infections upon Pulmonary Tuberculosis in Man, and the Measures, Preventive and Curative, for dealing with them."

AMERICAN students of *Characeæ* will be interested to learn that, through the purchase of the herbarium of L. J. Wahlstedt, the Field Museum of Natural History has rendered available to them a wealth of authenticated material in that family. The material comprises a large series of specimens that have been attested by Alex. Braun, Rabenhorst, Stizenberger, Norstedt, Wahlstedt and Allen. The total collection numbers 1,750 sheets.

THE United States Pharmacopœial Convention at its meeting held at the Hotel New Willard in Washington, D. C., May 10–13, elected the following officers: *President,* Dr. H. W. Wiley, of the Bureau of Chemistry, Washington, D. C.; *first vice-president,* Dr. N. S. Davis, of Illinois; *second vice-president,* Charles Caspari, Jr., of Maryland; *third vice-president,* O. T. Osborn, of Connecticut; *fourth vice-president,* Leo Eliel, of Indiana; *fifth vice-president,* W. A. Bastedo, of New York; *secretary,* M. G. Motter, of the District of Columbia; *assistant secretary,* Dr. Noble P. Barnes, of the District of Columbia; *treasurer,* S. L. Hilton, of the District of Columbia. The board of trustees, for the expenditures of the convention, was elected as follows: J. H. Beal, of Ohio; F. W. Meissner, of Indiana; W. J. Schieffelin, of New York; G. H. Simmons, of Illinois, and H. M. Whelpley, of Missouri. The committee on revision of the Pharmacopœia was elected as follows: J. P. Remington, H. Kraemer, C. Caspari, Jr., C. L. Diehl, J. O. Schlotterbeck, A. B. Lyons, H. C. Wood, Jr., J. M. Osborne, M. I. Wilbert, H. H. Rusby, Reid Hunt, A. R. L. Dohme, A. B. Stevens, G. M. Beringer, E. G. Eberle, L. E. Sayre, E. Kremers, W. A. Puckner, L. F. Kebler, C. S. N. Hallberg, C. H. La Wall, G. D. Rosengarten, V. Coblentz, J. W. Hatcher, J. M. Good, H. V. Arny, J. A. Koch, S. P. Sadtler, W. Bodemann, J. H. Long, O. Raubenheimer, C. E. Vanderkleed, T. Sollman, W. H. Nixon, J. C. F. Anderson, N. S. Davis, J. M. Francis, C. E. Caspari, R. H. True, W. N. Gregory, H. M. Gordin,

J. W. England, C. W. Edmunds, E. H. Bartley, G. W. Diekman, P. Marvel, W. Haines, W. G. Alpers, L. C. Hopp, Albert Plaut.

Dr. J. N. Rose, associate curator in the Division of Plants, U. S. National Museum, accompanied by P. S. Standley and Paul G. Russell, of his staff, has just returned from a collecting trip through southwestern United States and western Mexico. It has resulted in the adding of more than ten thousand specimens forming some three thousand numbers to the U. S. Herbarium. Dr. Rose's field work began at Big Springs, Texas, and extended as far west as Tucson, Arizona, whence he followed the West Coast Route of the Southern Pacific Railroad as far south as Acaponeta in Tepic. The collection includes various fiber, rubber and economic plants as well as numerous seeds of useful and ornamental vines and shrubs. Among the specimens obtained that were especially interesting, is a curious traveler's vine, which is a plant that furnishes an abundance of drinking water; a giant morning-glory forming a tree two feet in diameter; a strangling fig which is able to kill the largest tree in the forest; an ear-pod tree which has a fruit resembling the human ear—whence its name; a gourd tree which bears large fruit along its trunk; a silk-cotton tree covered with great balls of snow-white cotton; and a monkey rattlebox tree which is covered with large mallow-like fruit which explodes with a loud noise. Some rare palms, century plants and cacti that were collected were sent to Washington and are now on exhibition in one of the greenhouses of the Department of Agriculture. This expedition was conducted by the U. S. National Museum in association with the New York Botanical Garden and the Desert Laboratory of the Carnegie Institution of Washington.

Mrs. Mary M. Emery, of Cincinnati, O., has purchased a tract of wooded land in a residence district and has placed it under the charge of H. M. Benedict, associate professor of biology in the University of Cincinnati, for the purpose of establishing a "city bird reserve." The land will be fenced with a cat-proof fence, water, food and nesting materials will be provided and a test made of the possibility of bringing back the native birds to the city. It is hoped that the plan will prove so successful as to be copied in other communities. Now that the birds in the fields are protected by law and progress is being made in the establishment of breeding reserves for sea birds, the time seems ripe for the inauguration of a definite campaign to increase the bird life of our towns and cities. This first experimental reserve will be known as the "Mary Emery City Bird Reserve." Information regarding the details of fence construction, suitable locations, food and care, will be gladly given by the biological department of the University of Cincinnati to any who may contemplate the establishment of a "city bird reserve" in their own community.

The *British Geographical Journal* states that an expedition organized by Mr. Douglas Carruthers, in conjunction with Mr. J. H. Miller and Mr. M. P. Price, who are financing it, will leave England at the end of March for northwestern Mongolia. The chief object of the expedition is to explore zoologically, botanically, and, as far as possible, geographically, the basin of the upper Yenesei River. The journey out will be made through Russia and Siberia to Krasnoyarsk, and thence up the Yenesei to Minusinsk. Here the expedition will fit out, and, leaving Russian territory, pass over into Chinese Mongolia. The upper Yenesei and its tributaries are almost completely surrounded by high mountain ranges, which form a secluded basin. In this basin dwells a curious tribe, the Sayotes, who appear to be confined to this restricted area. On the completion of the work in the actual basin of the upper Yenesei, the expedition will pass through Dzungaria to Kulja, which will be reached some time in November. After this Mr. Carruthers and Mr. Miller hope to winter in the Tarim basin, and then to continue their explorations in the spring in the Chinese provinces of Kansu and Alashan. That there is much of interest to record about the tribes of this region is shown by the fact that it includes the original homes of the

Turkish and Finnish races. Zoologically, the Yenesei is important as being the line of demarcation between the faunas of eastern and western Siberia. And if the expedition is able to reach Alashan and neighboring regions, there will be valuable geographical work to be done and problems regarding the desiccation of central Asia to be solved.

UNIVERSITY AND EDUCATIONAL NEWS

BY the will of Isaac C. Wyman, of Salem, Mass., a graduate of Princeton College, who died on May 18, most of his estate is bequeathed to Princeton University, to be used in whole or in part for a graduate school. Mr. John M. Raymond, of Salem, Mass., and Professor Andrew F. West, dean of the Graduate School were named as trustees. The daily papers estimate the value of the bequest to be from $2,000,000 to $10,000,000.

THE Jefferson Medical College of Philadelphia, has received a gift of $60,000 from Mrs. Maria Gross Horwitz, daughter of the late Professor Samuel D. Gross, the eminent surgeon, to endow the "Samuel D. Gross Chair of Surgery."

ASSISTANT PROFESSOR J. G. JACK will conduct a Field Class at the Arnold Arboretum, Harvard University, on Saturdays during the spring and early summer, to assist those who wish to gain a more intimate knowledge of the native and foreign trees and shrubs which grow in New England.

DR. E. J. WILCZYNSKI, associate professor of mathematics in the University of Illinois, has accepted a similar position in the University of Chicago.

DR. J. W. YOUNG, assistant professor of mathematics in the University of Illinois, has been appointed head of the department of mathematics in the University of Kansas.

MR. EDWARD M. WELLISCH, of Cambridge University, has been appointed assistant professor of physics in Yale University.

THE following appointments have been made at the School of Mines of the University of Pittsburgh:

A. E. Ortmann, Ph.D., professor of physical geography.

P. E. Raymond, Ph.D., professor of invertebrate paleontology.

S. L. Goodale, A.M., E.M., assistant professor of metallurgy.

L. K. Acker, Jr., E.M., instructor in mineralogy and geology.

G. T. Haldeman, E.M., instructor in mining.

Earl Douglass, A.M., M.S., instructor in vertebrate paleontology.

H. B. Meller, instructor in mining.

Dr. A. B. Wallgren, lecturer on first aid to the injured.

Alexander Silverman, lecturer on glass manufacture.

W. F. Fischer, E.M., assistant in petrography.

N. L. Estabrook, assistant in mineralogy.

J. B. Keller, assistant in assaying.

The year has been extended to four terms of 12, 12, 11 and 10 weeks each, so that a student can complete his course by working any three of the terms each year. He may also complete his work and graduate in three years if he takes four terms a year. A student, as heretofore, in this school can substitute a year of practical work done under the school's direction for one year of the usual class and laboratory work, and in this way graduate in three years. Some thirty-five thousand dollars worth of material has been added to the equipment during the past year.

MR. C. L. BOULENGER, of King's College, Cambridge, has been appointed to the lectureship in zoology at Birmingham University rendered vacant by the resignation of Mr. Leonard Doncaster.

DISCUSSION AND CORRESPONDENCE

WEISMANNISM, A CRITICISM OF DIE SELEKTIONSTHEORIE[1]

A NEW publication from the pen of August Weismann naturally must excite curiosity among biologists, not so much with regard to possible new ideas and theories, but rather with reference to the question how far the author has corrected and modified his old views in order to do justice to the numerous

[1] "Die Selektionstheorie." Eine Untersuchung von August Weismann. Jena, 1909. 70 pages, 1 plate and 3 text figures.

and serious objections to them advanced by various adversaries.

The title of the present booklet might suggest that Weismann had the intention of doing something like this, for his conception of the principle of selection is one of his chief peculiarities, which has been most vigorously attacked. But perusing this book, we find that not the slightest attempt has been made to discuss seriously these objections. Here and there a feeble show is made, as if he had paid attention to them, but generally he discusses only minor points, and avoids the most essential criticisms, those which, when admitted as correct, would inflict the finishing blow to that particular type of evolution-theory known as *Weismannism*. And further, a peculiar feature of the present book is that in certain cases Weismann admits that his critics are right in a particular point, but that he nevertheless insists in maintaining his old position and his old views about this point. We occasionally have come across this way of arguing in informal discussions with persons belonging to the weaker sex, but never, as far as we can remember, in a scientific treatise which pretends to be serious.

The whole book is an eulogy on selection and its power to *create new things*. Weismann believes, if this is admitted, then there will be no difficulty whatever in understanding the origin of the whole organic world, and consequently also the origin of new species by natural selection will be clear. He claims that he stands, in maintaining this view, upon the original standpoint of Darwin. *But Darwin never said that new species are created by natural selection.* Indeed, there is the title of Darwin's book, "The Origin of Species by Means of Natural Selection," and it must be confessed that, reading the title alone, it might be interpreted this way. But there are some people who have a habit of looking more closely at things, books especially, and when they began to read Darwin's book, they found out that there is a distinction of two processes within the whole great process of evolution: the one is the *transformation of species*, that is to say, the change of *one* existing form of life into *one* other one, and the other is the *differentiation of species*, that is to say, the dividing of *one* existing form into *two* or *more* other ones. The latter process is strictly the *origin of new species*, or, as it has recently been called, the process of *speciation*.

For the first process, the transformation of species, Darwin introduces the three factors: *Variation, Inheritance* and *Natural Selection*,[2] and treats of them in the first five chapters. But incidentally he also discusses the second process, the origin of new species. He does this chiefly in the fourth chapter, where he talks of the divergence of character.[3] As the writer has shown elsewhere,[4] Darwin feels a little uneasy about this point. Nevertheless, he gives a tentative answer, and this is, that new species originate, if they are "enabled to seize on many and widely diversified places in the polity of nature,"[5] or, "if (they) become fitted for . . . different habits of life or conditions."[6] This is exactly what by subsequent writers has been called *separation, isolation, bionomic separation*, and for which possibly the best term is "*ecological segregation.*" And I hope by mentioning these words Weismann may recollect that they are intended to express something, and that they are supposed to have a definite place within the evolution-theory. In fact, the working out of this principle is the most essential improvement added by subsequent writers to Darwin's theory.

The above distinction between transformation of species (Umwandlung der Arten) and the origin of new species (Entstehung neuer Arten) has been exposed again and again, has been discussed at such a length that it has actually become tiresome to have to repeat it. Any child should be able to see the point. But Weismann evidently fails to do so. All his previous writings, and also the present book, are, with reference to the dis-

[2] See summary at end of chapter IV., p. 102 ("Origin of Species," American ed., 1884).

[3] *Ibid.*, p. 86.

[4] *Pr. Am. Phil. Soc.*, 35, 1896, p. 175 ff.

[5] "Origin of Species," p. 87.

[6] *Ibid.*, chapter VII., p. 169.

tinction of these two processes, a maze of confused ideas, and he most obstinately continues to transfer the factor of selection, which Darwin introduced for the first process, and to apply it to the second process (speciation). Of course, in the writings of Weismann it is hard to quote a passage where he does this clearly and unmistakably, since in this respect clearness is altogether lacking, but, in the present book, it is easily seen that he actually intends to apply the principle of selection to the formation of new species by his reference to the mutation theory of de Vries. Of course, de Vries makes the same fundamental mistake. The mutation theory, as should be evident to everybody, deals preeminently and emphatically with the question of speciation; at any rate, de Vries claims that it does, if he wants to explain the *origin of* NEW *species by mutation,* and consequently it can not at all come into conflict with Darwin's principle of selection, which is intended only as a factor in the transformation process. Nevertheless, Weismann (as well as de Vries) regards the mutation theory as opposed ("Einwurf," p. 7) to the selection theory! Any one who expresses views like these demonstrates only that the true Darwinian theory is not understood by him, and that he has not the slightest idea of what the meaning and significance of de Vries's experiments are. As has been demonstrated elsewhere,[7] de Vries himself did not understand the bearing of his experiments upon the evolution theory in general, and, consequently, made the most serious mistakes in their interpretation.

This misunderstanding of Darwin's theory explains why Weismann so stoutly maintains that selection may *create new things: he needs some explanation for the origin of new species.* But this idea of his has been criticized so often that he is forced to pay at least some attention to the attacks, and, indeed, he admits that selection can not do anything without the material, with which it is to work, being furnished by variation: a number of writers have called his attention to this, and have reminded him that, if this is so, it is not logical to say that natural selection, by killing the unfit variations, "creates" new ones, but that the word "preserves" should be used. This objection is absolutely well founded, as everybody will grant, and Weismann has been cornered by it so completely, that no other escape remains for him but to say that this objection is "nonsensical" (sinnlos, p. 81). Further comment is unnecessary.

In his treatment of the "Lamarckian principle" and the causes of variation, Weismann shows the same lack of understanding, or, if not, a rather vicious tendency to distort facts and ideas. The Lamarckian principle, in its widest sense, which is also accepted by Darwin, says that the variations which are transmitted to the offspring are *caused* by the environment. It is true, Lamarck himself discussed "chiefly" (hauptsaechlich) use and non-use of parts as cause of variation. But Weismann admits, by using the word "chiefly," that there *are* others, and he surely ought to know that Darwin and subsequent writers have enlarged this principle so as to regard all reactions of the body to environmental factors as variations in this sense (acquired characters). In the present booklet, however, Weismann restricts the Lamarckian principle strictly to "use and non-use," and then, of course, it is easy for him to show that in particular cases quoted by him the Lamarckian principle does not apply.[8]

His chief argument against the Lamarckian principle is that we are to entertain "strong doubts" (p. 6) against the cooperation of this principle, and that the transmission of acquired characters is "hard to

[7] See SCIENCE, 23, May 11, 1906, p. 746; 24, August 17, 1906, p. 214; 25, February 1, 1907, p. 185.

[8] *This is a beautiful illustration of Weismannian logic.* On page 6, line 10, he uses the word "chiefly" (hauptsaechlich) in this connection, while almost immediately below, on the bottom line of the same page, "functional" variations (by use and non-use) become the "only ones" (allein), which constitute the Lamarckian principle. This surely justifies what we have said above on his tendency to distort things.

imagine" (kaum vorstellbar). There is hardly a single paper of Weismann on evolutionary subjects which does not assure us of this. But the reviewer has not seen in any one of them a clear statement what these doubts are, and his personal power of imagination, which surely has the same convincing force as Weismann's, is entirely adequate to admit this theory. Weismann's opinion to the contrary and his idea of "germinal variation" is a working hypothesis pure and simple, and should be used only as such; but the two opposite views should never be used as evidence against each other, and this is what Weismann does again and again, also in the present book. *The Lamarckian principle is wrong, because it is in conflict with the Weismannian theory of the germ plasm, and the latter is correct, because, since the Lamarckian theory is wrong, it is the only way to explain evolution.* This is practically the essence of Weismann's argumentation: a schoolboy's blunder against logic.

On the other hand, Weismann purposely overlooks the recent experimental evidence for the inheritance of acquired characters, furnished now by quite a number of biologists. He knows, at any rate mentions, only two of them, Semon and Kammerer, and says that, according to Pfeffer, those of the first are "incorrect" (nicht richtig), and that he is going to show that those of the latter can not be regarded as convincing. The reviewer is much afraid that this latter demonstration will rest upon something like Weismann's argument, which intended to show that his own experiments on *Polyommatus* do not furnish support for the Lamarckian view. As to the latter, I beg to compare what I have said some time ago with regard to this matter,[9] to which I have to add nothing, and which clearly shows that Weismann's conception of the Lamarckian principle is entirely wrong, in fact that he does not at all understand what the essential point in it is.

We may summarize our conclusions as to the Weismannian theories and the Weismannism as follows: In the beginning, Weismann proposed his theory of the germinal variation, and the subsidiary theory of the all sufficiency of natural selection in opposition to the current view of the inheritance of acquired characters, without positive support, but chiefly on account of the supposed insufficiency of the latter view. At that time it was a working hypothesis as well as the other theory. In his subsequent writings Weismann tried to strengthen his position, but he was forced, first of all, to abandon his idea of the "amphimixis" as the cause of germinal variation, and further he introduced his theory of the "germ plasm" and its variation, and, in close connection with the latter, his theory of inheritance.

By the theory of the "variation of the germ plasm" he *changed his original views of "germinal variation" in a fundamental way,*[10] a fact which was never acknowledged by him, and further, in connection with this, he was forced to admit facts which are strongly in favor of the Lamarckian principle, which, however, he denied by the argument: *if Lamarckian inheritance can be explained by the germ-plasm theory, there is no Lamarckian inheritance.*

His special views on the principle of selection, although attacked repeatedly and disproved, in part as incorrect, in part as illogical, were always maintained and defended by him, but only at the risk and to the detriment of sound logic. At the present time, in the booklet reviewed here, he is upon the old standpoint; he has not considered valid objections to his views, and has passed over the most serious in silence, repeating again and again his old blunders and absurdities.

This has gone on too long. *Weismannism* has become a term characterizing not only a particular brand of Darwinism "made in Germany," but also a particular kind of loose and illogical reasoning, which we are not wont to regard as a product of German universities. This harsh criticism would not be necessary but for the fact that Weismannism has become a scientific "creed"

[9] See *Biol. Centralbl.*, 18, 1898, p. 153, and Science, 23, June 22, 1906, p. 950.

[10] See *Biol. Centralbl.*, 18, 1898, p. 139 ff.

among a certain class of biologists, and, in consequence, has delayed progress in biology for a considerable time. Weismann alone is responsible for the discredit into which the Lamarck-Darwinian view of the causes of variation has fallen: the latter has become unfashionable and "not up to date." Thus biologists were and are to a certain extent afraid of looking at evolutionary questions under the assumption that the "inheritance of acquired characters" might possibly be correct, and failed to do, what was most needed, to prove or disprove this view by the way of experiment. Fortunately, at the present time, conditions seem to improve: observations and experiments are being made which have a distinct bearing upon this question, and we may say that unexpected results are forthcoming which tend to show that the Lamarckian principle, which is also Darwin's view of the origin of transmissible variations, should be reckoned with. We only hope that this spirit of emancipation from a scientific dogma may prosper and flourish, and true progress will be assured.

A. E. ORTMANN

CARNEGIE MUSEUM,
PITTSBURGH, PA.

NOTE ON THE MARKING SYSTEM IN THE ASTRONOMICAL COURSE AT COLUMBIA COLLEGE, 1909–10

AFTER the first half year's work in the introductory astronomical course at Columbia had been finished, a test was made to ascertain the precision with which marks were assigned after the mid-year written examination. The answer books as handed in by the students were arranged in alphabetical order and each fifth book selected. In this way eleven answer books were obtained, representative of the class as a whole and chosen entirely without bias.

These eleven books were then marked by the following six professors of astronomy: Professor John M. Poor, of Dartmouth; Professor F. R. Moulton, of Chicago; Professor Wm. Beebe, of Yale; Professor O. M. Leland, of Cornell; Professor S. A. Mitchell, of Columbia; Professor Harold Jacoby, of Columbia.

No professor was permitted to see the marks assigned by the others; all were instructed to let the mark 10 represent that degree of proficiency which may be expected reasonably from a competent student who works hard; and 6 was to be considered a pass mark. No attention was to be paid to neatness, spelling, etc.; the marks were to be assigned upon astronomical proficiency only. The following table contains the results, the names of the professors being replaced by letters of the alphabet so as not to make public which professors gave the highest or the lowest marks.

Book No.	A	B	C	D	E	F
1	9	9.0	8.5	7.2	9	7.3
2	7	6.6	7.0	5.9	6	6.5
3	9	9.0	8.8	7.2	8	8.0
4	10	9.4	9.9	8.0	10	9.2
5	7	6.2	6.7	5.8	7	5.9
6	10	9.8	9.6	7.6	10	9.5
7	6	5.8	6.3	4.6	7	5.4
8	9	9.3	9.7	8.0	9	8.8
9	8	5.7	9.0	6.7	10	8.7
10	10	8.5	9.1	6.2	9	9.0
11	9	9.0	9.5	6.1	8	9.0
Average	8.5	8.3	8.6	6.7	8.5	7.9

The professor in the column D, whose average mark is 6.7, appears to have taken 5 instead of 6 as his pass mark; he explained in a letter that only one of the students should fail to pass in his opinion, although he assigned three marks under 6.

Making due allowance for this circumstance in the case of professor D, there is a very close accord in the marks given by the various professors. It would appear that the students have attained a very high average in their work, and that the marking system is more precise than some of its critics would have us believe. Possibly this may be due to the fact that astronomy is an exact science.

For the information of other teachers, the examination paper is appended.

HAROLD JACOBY

COLUMBIA UNIVERSITY,
April, 1910

COLUMBIA COLLEGE
MID-YEAR EXAMINATION, FEBRUARY 3, 1910
Astronomy 1

Answer three questions only in each numbered group

1, *a*. Define: celestial sphere, declination, hour-angle.
1, *b*. Describe the ecliptic circle and explain why we always see the sun in that circle.
1, *c*. What visible phenomena are produced by the earth's axial rotation?
1, *d*. Prove that the altitude of the celestial pole is everywhere equal to the latitude.
2, *a*. Explain sidereal and solar time.
2, *b*. Why does the vernal equinox occur on or about March 21?
2, *c*. Explain the reason for time-differences between different places on the earth.
2, *d*. In an ordinary horizontal sundial, what is the angle of elevation of the gnomon, and why?
3, *a*. If a small round steel ball is dropped from a tower, will it reach the earth at a point directly under the point from which the ball was allowed to fall?
3, *b*. If not, where will it reach the earth, and why?
3, *c*. How is the length of the earth's radius determined?
3, *d*. What is the "torsional constant" and how is it determined for any given torsion balance?
4, *a*. Why is summer hotter than winter?
4, *b*. In the northern hemisphere, is summer longer or shorter than winter? Why?
4, *c*. Explain tropical and sidereal years.
4, *d*. Explain the supposed relation between the age of the Great Pyramid in Egypt and the precession of the equinoxes.
5, *a*. Explain the aberration of light.
5, *b*. What are the four constituent parts of a date?
5, *c*. What is the leap-year rule in the Gregorian calendar?
5, *d*. How does the apparent angular velocity of the moon on the sky compare with the sun's, and why?
6, *a*. How is the moon's distance from the earth ascertained.
6, *b*. Explain two lunar librations.
6, *c*. What are occultations, and how are they used to determine terrestrial longitudes?
6, *d*. Demonstrate Kepler's law of areas under the action of a central force.
7, *a*. Define sidereal period of a planet,
Synodic period of a planet,
Conjunction.
7, *b*. Derive formula for computing the sidereal period from the synodic period.
7, *c*. Explain the connection between the visibility of a planet and its synodic motion.
7, *d*. Why does the synodic period approach 365 days as a limit for the outermost planets of the solar system?

THE DEFINITION OF FORCE

TO THE EDITOR OF SCIENCE: Professor Henry Crew, in his presidential address before the American Physical Society,[1] comments unfavorably on the definition of force given by me in a letter in SCIENCE of December 24, 1909, viz., "Force is a pull or a push, something that causes or tends to cause either motion or a change in the velocity or direction of motion." He expresses a "fear" that this definition is used by "not a few students of physics."

An elaboration of the definition, given many years ago by Professor I. P. Church, is as follows:

A force should always mean the pull, pressure, rub, attraction (or repulsion) of one body upon another, and always implies the existence of a simultaneous equal and opposite force exerted by that other body upon the first body, *i. e.*, the *reaction*. In no case should we call anything a force unless we can conceive of it as capable of measurement by a spring balance, and are able to say from what body it comes.

That "a few students of physics" use this definition ought not to be the cause of "fear" to any professor of physics; on the contrary, it should be a source of gratification. It is safe to say that nine tenths of all those students of physics who have occasion after their college days to make use of their physics are going to be either engineers or mechanics, and in that case they will have to learn this "standard definition of the engineer." It is well for them to learn it while they are young.

Professor Crew gives as "the one perfectly *correct, competent* and *complete* description of force" the "rate of change of momentum," and he credits Galileo and Newton with having thus defined it. I can not find, however, in the quotations he gives from Galileo and

[1] SCIENCE, April 8.

Newton any suggestion of such a definition. Galileo, according to the extract quoted, said that "the properties of accelerated motion are defined, without consideration of their causes, in such a way that the momentum (of the body) increases uniformly from the initial condition of rest in simple proportionality to the time," but this is a very different thing from a denial that force causes motion, or from an assertion that force *is* the rate of change of momentum.

Newton's second law of motion, according to one of the translations, is: "If a body be acted on by several forces it will obey each as though the others did not exist, and this whether the body be at rest or in motion." It would be difficult to explain this law if we substitute for the word "forces" the words "rates of change of momentum," especially if the body is at rest and therefore has no momentum.

Referring to the example of the action of force given in my former letter in SCIENCE, a stone is suspended from a projecting shelf by an elastic cord. The earth's gravitation acts on the stone. There is a tension and an elastic resistance in the cord. The word force is used as a generic term to include all those varieties of force that are designated by the words gravitation, tension, resistance, stress, etc. As long as the cord sustains the stone these several forces act, but as there is no motion there is no momentum, nor rate of change of momentum, which Professor Crew says force "is."

Let the cord break. We now have motion, which is change of position during time; velocity, ds/dt; momentum and constant acceleration; all so long as the stone is falling freely, and we may write the equations:

$$FT = MV; \quad F = MV/T; \quad F = MA; \quad V = 2S/T.$$

Before the cord breaks we have two elementary concepts to deal with, matter and force. After the cord breaks, and while the stone is falling, we have two other elementary concepts, space and time, and a few complex concepts: velocity, $V = 2S/T$ or ds/dt, momentum, $W/g \times V$, and acceleration, $(V_2 - V_1)/T$. It is only by a somewhat complex mathematical deduction that we arrive at the "pure concept of the intellect, but a precious concept," $F = (MV_2 - MV_1) \div T$, which Professor Crew says is a "perfectly correct, competent and complete description of force." A boy twelve years old easily grasps the concept that the force acting on the stone is the pull that tends to break the cord, and while he does not know what force is except by its effects, he easily conceives that it is the cause of motion when the cord breaks; it takes a metaphysician to arrive at the definition that force *is* the time rate of the change of momentum.

Let us return to the equations. In order to make them true we must choose certain units for each quantity. Some writers on physics say that the unit of mass is 1 lb. and that the unit of force is a poundal. Others say that the unit of mass is 32.2 lb. and the unit of force 1 lb.; still others that the unit of weight (quantity of matter, W) is 1 lb. and that M is merely an expression to signify W/g. One book on high-school physics defines mass as the quantity of matter, and gives its unit as 1 lb., and also gives the unit of weight (resultant of the attraction of gravitation) as 1 lb., and later gives the equation $W = Mg$, which is wrong if the definitions of the units are right, for in that case $W = Mg$ becomes $1 = 1 \times 32.2$. In the C.G.S. system there is no such trouble, for in it there are four different units to represent the four elementary quantities, viz.: dyne, gramme, centimeter, second. It is only when we try to graft the so-called absolute system on the English system, with its pound representing both quantity of matter and force, and invent new terms, such as the poundal and the gee-pound, to get over the difficulty which exists in the minds of the metaphysical physicists (but not in the minds of engineers, to whom $M = W/g$), that confusion begins.

The equation $F = (MV_2 - MV_1) \div T$ may be interpreted as follows: When a force F acts during a time T on a body which is free to move, and whose mass (W/g) is M, and gives the body an increase of velocity from V_1 to V_2 during that time, then if the units

of the several quantities are chosen so as to make the equation true, the amount of the force is numerically equal to $(MV_2 - MV_1) \div T$, or to the rate of change of momentum.

Let $T = 1$ second, $V_1 = 0$, $V_2 = 32.2$, $W = 1$ lb., $M = 1/32.2$, then the equation reduces to $1 = 1/32.2 \times 32.2$, or force = mass $\times$ acceleration, and it is correct, but if the unit of M is taken as 1 lb. then we have $1 = 1 \times 32.2$, which is incorrect.

The "correct, competent and complete" definition that force *is* the rate of change of momentum, no doubt is a metaphysical deduction from the formula, but it is neither correct, competent nor complete, and is not a definition at all. It assumes that we can translate the sign of equality (=), which really means "is numerically equal to" by the word "is." It is not true even as to equality except under certain limited conditions, viz., 1, that the units have certain values, such as $M =$ lbs. $\div g$, and 2, that the body is free to move. It is not true when a force is applied to a body not free to move, nor when a force is being applied to cause a body to move at a constant speed against a constant resistance, as when a canal boat is being towed, nor when a force is applied to a body moving with increasing speed with decreasing acceleration, as when an engine is bringing a train up to full speed.

"The debt that physics owes to metaphysics" is a sound castigation, for having introduced into physics such bad logic as that of making "equals" equivalent to "is," "darkening counsel with words," and substituting metaphysical deductions and complex concepts for simple definitions and concepts; and for introducing ideas that are so far from being "clear, sharp and definite" that they have to be unlearned or forgotten before the student can make satisfactory progress in engineering mechanics, and that they are discouraging even the high-school physics teachers themselves from teaching elementary dynamics, as was shown in Professor Edwin Hall's paper in Science of October 29, 1909. What is needed is a return to the good old definitions of Weisbach and Rankine, and a dropping of the metaphysical reasoning which has recently become the fashion.

Wm. Kent

Montclair, N. J.,
April 26, 1910

SCIENTIFIC BOOKS

SCIENTIFIC RESULTS OF SHACKLETON'S SOUTH POLAR EXPEDITION

The Heart of the Antarctic: Being the Story of the British Antarctic Expedition, 1907–1909. By E. H. Shackleton, C.V.O. With an Introduction by Hugh Robert Mill, D.Sc. *An Account of the First Journey to the South Magnetic Pole.* By Professor T. W. Edgeworth David, F.R.S. 2 vols., ill., plates. Philadelphia, J. B. Lippincott Co. 1909. $10 net.

It rarely falls to the lot of any single explorer to conjointly arouse such popular interest and contribute such important scientific knowledge as has been done by Sir Ernest H. Shackleton through his Antarctic expedition of 1907–1909. It should be realized that the inception, financeering, organization and successful administration of the expedition are due to Shackleton, it being a private venture unaided, and it may be also said unhampered by governmental offices.

Shackleton played an active part in Scott's Antarctic expedition, 1901–1903—when he was one of the four men who made a world's record of the farthest south—from which he was later invalided on account of scurvy. His early experiences were fruitful factors in his recent successes, which were in a measure due to improved conditions of food, clothing, shelter, transportation and travel methods.

Sailing from New Zealand, January 1, 1908, Shackleton established his permanent station at Cape Royds, Ross Island, at the base of Mt. Erebus. The expedition returned in 1909 with its members in health and its work done with wonderful success. In addition to the meteorological work at Cape Royds, the famous volcano Erebus was ascended and studied, the south magnetic pole located and visited, while the southern party attained a point within 93 geographical miles of the south pole.

FARTHEST SOUTH.—Very brief reference will be made to this extraordinary journey in which Shackleton and three companions in 127 days traveled 1,755 miles, an average of 13.8 miles daily, the party in its earlier travel being aided by Manchurian ponies who were killed and eaten.

For nearly 400 miles the route lay nearly due south, over the Great Barrier which is practically on the sea-level. Mountains then barred a south course in about 83° S., when they discovered Beardmore glacier valley which enabled them to proceed with slight deviations. This glacier proved to be a difficult, dangerous pathway, its crevasses nearly costing their lives while pressure ridges and moraines made progress slow up the steep ascent—6,000 feet in 100 miles.

The glacial valley was between sandstone and slate mountains, in which were found fossils and coal to about 86° S., where the mountains vanished and there was visible only an immense, unbounded, ice-covered plateau. The ice rose steadily and was still rising to the south when through lack of food the party turned back on January 9, 1909, from a point in 88° 23′ S., 162° E., at an elevation exceeding 11,000 feet. For weeks the party never had the temperature above zero Fahrenheit.

This southern journey was made under such conditions of intense cold, constant danger and continued semi-starvation, as makes its simple record a most thrilling story for adventurous or sympathetic natures. While it does not differ in its material aspects from many polar journeys it had a spiritual side that must appeal strongly to every true scientist.

Geological specimens were collected from time to time on the outward march, the farthest within about 300 miles of the pole, and all gathered up on their return. Chilled by low temperatures, suffering from bruises and strains through glacier travel, with depleted strength, prostrated at times by dysentery, and once traveling 31 hours without solid food, the party not only dragged these specimens some 500 miles homeward without abandoning them but even refrain from mentioning this load, drawn at the risk of their lives, save to say "at the ice-edge [near home] taking on only . . . specimens."

A similar heroic spirit of scientific devotion was displayed by David Mawson and Mackay in locating the magnetic pole. It was only by desperate, repeated and prolonged efforts that they reached the surface of the continental ice-cap of South Victoria Land, where they pursued to success their magnetic work. It was not alone that they experienced most trying physical sufferings, but that they also faced the extreme hazard of their lives, knowing that with the advancing season the sea would open during their prolonged absence and leave them without food.

Such heroic examples in the field match well the sacrificing spirit of scientific research so often displayed within the environment of modern civilization.

MOUNT EREBUS.—The ascent and survey of this lofty active volcano were productive of interesting data. Rising to the height of 13,350 feet, its four superimposed craters have for centuries overlooked the great oceanic ice cap, contrasting aspects of eternal fire and enduring ice.

When discovered by Ross in 1841 the crater was discharging molten lava which flowed down in streams.

Professor T. W. E. David gives an interesting account of the mountain. Of its three inactive craters the oldest rises to 6,500 feet with a diameter of six miles, while the second is two miles across at an elevation of 11,350 feet. The outline of the third, at 12.200 feet, was almost obliterated by the material of the modern active cone and crater which rose about 800 feet above the former.

The active crater of Erebus, three times as deep as that of Vesuvius, is about 900 feet deep, and one half a mile in diameter.

> Molten lava still wells up into the crater. . . . Fresh volcanic bombs on comparatively new snow are evidence that Erebus has recently been projecting lava to great heights.
>
> A most striking feature was the long row of steam jets about 300 feet below the inside rim of the crater.
>
> The ice fumaroles (some 50 were seen) are especially remarkable. These unique ice-mounds

have resulted from the condensation of vapor around the orifices of the fumaroles.

It will be obvious that Erebus is very interesting geologically on account of its unique fumaroles, its remarkable feldspar crystals and rare lavas, and as a gigantic tide gauge to record the flood level of the greatest recent glaciation of Antarctica.

Accounts of several eruptions are given in which the ejected steam rose from 6,000 to 10,000 or more feet above the crater.

Biology.—As might be expected, far the greater portion of biological data pertain to bird life, especially to the penguins, whose habits and methods are treated with interesting fulness.

Save rare specimens of the lowest forms of lichens, mosses and algæ, vegetation was entirely lacking. Doubtless the most important observations were those relating to microscopic fresh-water animals, of which Murray says:

> On some of the moraines the growth of mosses and lichens was, comparatively speaking, luxuriant. A dried-up pool, close by the penguin rookery, . . . was covered by green filamentous algæ. Around smaller lakes was seen a dingy green or brown plant resembling some of the foliaceous lichens in form.
>
> The plant-life consisted of various spheres and threads of blue-green algæ. The animals were more abundant . . . the rotifers and water-bears most important in point of numbers. [There were] thread-worms; . . . protozoa, each of a single cell . . . active infusoria . . . and the slow-moving rhizopods. . . . Skins of animals higher in the scale, . . . mites related to the cheese mite, small shrimps (crustacea) . . . were occasionally found.
>
> A temperature of — 40° F. did not kill the rotifers. They were alternately frozen and thawed weekly for a long period and took no harm. They were dried and frozen, thawed and moistened and still they lived. They were dried, the bottle in which they were immersed in boiling water and still a great many survived.
>
> Such is the vitality of these little animals (rotifers and water-bears) that they can endure being taken from ice at a minus temperature, thawed, dried and subjected to a temperature not far short of the boiling point, all within a few hours. . . . These are animals comparatively high in the scale. The rotifers are worms, and the water-bears are cousins to the insects and spiders.

Of the twelve kinds of creeping rotifers two were viviparous, one belonging to a genus (*Adineta*) of which no other known member is viviparous.

Dredging in depths less than 100 fathoms "the bottom appeared to be carpeted with a dense growth of living things."

Scant space is given to marine biology, perhaps as of little popular interest. There were obtained sponges, sea-weeds, anemones, tunicates, big-headed fishes (*Nototheia*), carnivorous whelks (*Neobuccinum*), tube-dwelling worms, crustacea, corals, sea-butterflies, diatirus, sea-spiders, etc.

Of the phosphorescence displayed by some of the worms from the bottom and by the copepods of the open sea, Murray says:

> The phosphorescence is displayed by cold-blooded animals, living in a temperature always some degrees below the freezing-point of fresh water, and it is shown equally throughout the winter.

Geology.—Professor T. W. E. David and Mr. R. E. Priestley discuss the geological data in connection with those of preceding Antarctic expeditions. In the Victoria Land region previous researches, especially those by H. T. Ferrar, disclose:

> An ancient complex of gneisses and gneissic granites, with mica-schists, calc-schists and quartzites, and that these rocks are capped for a great distance by a formation almost horizontally bedded, called the *Beacon sandstone*.
>
> Amongst volcanic rocks are comprised hornblende-basalts, olivine basalts, dolomites, basalt tuffs, kenytes, phonolitic trachytes and phonolites. Amongst the foundation rocks of South Victoria Land Prior records crystalline limestones with chondrodites, gneiss, granites, diorites, camptonites, kewantites and banakite.

David says:

> The oldest rocks seen by us . . . consist of banded gneiss, gneissic granite, grano-diorite and diorite rich in sphene. In some spots masses of very coarse white crystalline marble are interspersed in the gneiss. . . .
>
> The next oldest sedimentary rocks appear to be the greenish grey slates brought by the Southern Party from the surface of Beardmore glacier . . .

in approximately 84° S., . . . fragments blown on to the ice from . . . mountains further west.

The most important geological inferences put forward are:

The Beacon sandstone formation, which extends for at least 1,100 miles from north to south in Antarctica, contains coniferous wood associated with coal seams. [In 85° S. 7 coal seams aggregating 25 feet in thickness were found in one sandstone cliff, associated with coniferous wood.] It is probably of Paleozoic age.

Limestones, pisolitic in places, in 85° 95′ S., and 7,000 ft. above sea-level, contain obscure casts of radiolaria, which appear to be of older Paleozoic age.

The succession of lavas at Erebus appears to have been first trachytes, then kenytes, then olivine basalts. Erebus is, however, still erupting kenyte.

Peat deposits, formed of fungus, are now forming on the bottoms of some glacial lakes near 78° S.

Raised beaches of recent origin extend at Ross Island to a height of 160 ft. above sea-level.

SOUTH MAGNETIC POLE.—Of great popular interest, as well as of especial scientific importance, was the definite location of the south magnetic pole, a most valuable work done by Professors E. David, D. Mawson and Mr. A. Mackay. It involved an outward journey of unusual difficulties, which occupied three months and eleven days. Two months of arduous labor, constant suffering and repeated failures were experienced before the party succeeded in attaining the surface of the continental ice-cap of South Victoria Land, whereon the pole is situated, 260 miles inland. They were quite at the limit of their provision supply, as well as of their physical strength, when they reached on the ice-cap the pole, on January 16, 1909, in 72° 25′ S., 155° 16′ E., at an elevation exceeding 7,000 feet. Their necessarily prolonged journey nearly involved the lives of the party as the open sea cut them off on their return, but they were picked up fortunately by the *Nimrod*.

Professor Douglas Mawson, who made the observations, says:

In the interval between 1841, when [the south magnetic pole was approximately located from his ship by Sir James Clark Ross] . . . and 1902, when the *Discovery* expedition again located the magnetic pole, it had moved about 200 geographical miles to the eastward.

Observations of magnetic declination and dip taken at intervals . . . indicate that the magnetic pole has [since 1902] moved in a northerly and westerly direction.

The determination of the *exact center* of the magnetic polar area could not be made on the spot, as it would involve a large number of readings taken at positions surrounding the pole. Such observations [were impossible] under conditions of such low temperatures [about zero] and prevalent high winds.

AURORA AUSTRALIS.—Auroras were frequently observed, but rarely in the direction of the magnetic pole. Mawson says:

When at their greatest brilliancy the displays were powerful enough to throw shadows [confirming similar observation by the Lady Franklin Bay expedition in Grunell Land], but were yet insufficiently strong to allow of their being photographed. We obtained impressions, of little value, on photographic plates after about ten minutes' exposure.

TIDAL OBSERVATIONS.—By ingenious devices the tide was automatically registered, on a barograph drum, for about three months. The usual tidal movements were marked by oscillations, chiefly during blizzards, considered to be in the nature of *seiche* waves.

The tide record was a simple undulating curve with one maximum per day, attaining the greatest amplitude at full and new moon, and diminishing almost to nothing at the quarters.

When the record was analyzed it was resolved into two undulations, the larger one having the period equal to the lunar day, the smaller one having a period of half a day.

The tidal range is not given in the narrative, but from the reproduced record, without scale, it would appear to range from about 8 inches in the neaps to about 35 inches in the springs.

METEOROLOGY.—Tabulated meteorological data are wanting as is frequently the case in popular accounts of polar expeditions. It is, however, evident that the bi-hourly meteorological observations of Shackleton's party, con-

joined with those of his predecessors in this region, will be a valuable contribution to Antarctic climatology and meteorology, when discussed and published in detail.

Barometrical observations are lacking, but the comments of Murray are especially interesting, and worthy of close scrutiny, that the usually close relations between the wind and barometric changes were absent, though there was an evident connection between the wind and changes of temperature. He adds that violent blizzards were frequently experienced while the barometric pressure was steady or changing slightly, while rapid barometric changes were often noted during fine and relatively calm weather.

Judging from the reproduced barometric chart for May and June, 1908, the normal variations are small, as they only ranged from a maximum of 29.44 on May 7 to a minimum of 28.30 on June 17.

Temperature Observations.—As they are always of unusual interest in polar work, it is unfortunate that the greater number of observations were of temperatures below zero Fahrenheit. As the expedition had no mercurial thermometers scaled below zero, such observations were necessarily made from spirit thermometers, which usually tend to unduly low records, owing in part to the instrumental inaccuracies and in part to frequent derangements and untrained manipulation of the thermometers.

As to the exceedingly low temperatures of the great south polar plateau, with its elevation of more than eleven thousand feet, it should be borne in mind that they were in large measure due, to the extent of about fifty degrees, to the normal cold of elevation; they are therefore not strictly comparable with the temperatures at Cape Royds.

The annual mean temperature of Cape Royds, approximating zero Fahrenheit, although unusually low, is yet four degrees higher than that experienced by the Lady Franklin Bay expedition at Fort Conger, 81° 44′ N., 1881–1884. The monthly means at Cape Royds are approximately as follows: January, 25° F.; February, 13°; March, 4°; April, —12°; May, —11°; June, —13°; July, —16°; August, —16°; September, —12°; October, —4°; November, 14°, and December, 26°. While the three coldest months (June to August) are comparatively warm with their aggregate mean of —15°, the three warmest months (November to January) are extremely cold with their mean of 22°. It is not surprising that only the very hardiest forms of vegetable life are able to survive such an unfavorable land environment.

With reference to violent temperature interruptions, there are reproduced combined temperature and wind records for May and June, 1908. These charts show regular and intimate relations between wind and temperature changes. In every case, seven in all, of high winds rapid and great increments of temperature systematically followed. This intimate relation, Professor David states, obtains only in the winter season, practically disappearing during the summer months.

It appears that the high winds, sixty to seventy miles an hour, always came as part of the southerly blizzards, concerning which it is said:

> The temperature invariably increased considerably from the beginning of a blizzard towards its end. This rise was very marked (from) perhaps —30° F. . . . after 24 or 30 hours . . . to plus 15° F.

While Professor David suggests as possibly one of the important causes of this rise in temperature the usual Föhn compression, the reviewer considers it as practically the whole cause.

When abnormal barometric gradients near the south-polar plateau set up atmospheric movements with even a slight northern tendency, the intensely cold air of the polar plateau naturally follows the path of least resistance. This is through the valley of Beardmore glacier, with its downward gradient of 6,000 feet in sixty miles. The descent of such air-masses from an elevation of 11,000 feet to the sea-level must proceed with increasing velocity for the wind, while the rise in temperature must approximate sixty degrees from compression, independent of the latent heat set free by the accompanying snow-fall.

Winds, Surface and High-level.—Surface

winds at Cape Royds were either north from the sea or southerly from the plateau. On the southern journey south-southeast winds predominated, occasionally veering a few points. The direction was thus largely due to topographical conditions. At the farthest, 88° 23′ S., the many sastrugi trended from the south-southeast, and all blizzards were from that direction.

The record of the higher winds is most important. As Cape Royds is practically at the base of volcanic Mt. Erebus, the constant volcanic steam-cloud served as a gigantic wind-vane which was usually in full view. It developed that there were three normal wind-currents—the *surface* up to about 6,000 feet, the *middle-level* thence to about 15,000 feet, and the *high-level* above all. The direction of the *middle-level* was definitely shown by the many strongly marked sastrugi, from 11,000 to 12,000 feet, to blow from the west-southwest. Occasional eruptions sent steam-clouds upward from the crater of Erebus to a height of twenty thousand feet, and these cloud-streamers displayed clearly and persistently *high-level* current from the northwest. Interruptions and reversals of the various upper currents were noted in connection with violent blizzards. The detailed observations should throw much light on the atmospheric circulation of the southern hemisphere.

Precipitation.—This was entirely in the form of snow, which usually falls during blizzards. The annual amount at Cape Royds equalled about 9.5 inches of rain. The buried depot on the Great Barrier showed in six years and four months about 45 inches of melted water, or more than seven inches annually of rain.

ICE-CAPS AND GLACIERS.—Shackleton's journey furnished much information on the physical conditions attendant on the great Ice Age, of which the only surviving examples of note are Greenland and the continent of Antarctica —the latter of enormously greater extent and importance.

While existing data justify the belief that the ice-cap of Antarctica covers an area fifty per cent. greater than the continent of Europe, we now have positive evidence of an unbroken expanse of inland ice extending north and south more than 1,100 statute miles in a right line, from 72° 25′ S., the magnetic pole of Mawson, to 88° 23′ S., the farthest of Shackleton, and covering an arc east and west of fifty-five degrees of longitude south of the 78th parallel of latitude.

Erratic blocks and other proofs indicate that the thickness of the northern edge of the continental ice-cap near South Victoria Land exceeded by some two thousand feet that of the present wonderful inland ice.

Of the ice of the south-polar plateau at an elevation of 9,600 feet, Shackleton writes:

> I do not think that the land lies very far below the ice-sheet, for the crevasses on the ridges suggest that the sheet is moving over land at no great depths. The descent, towards the glacier proper, is by a series of terraces.

Everywhere were evident signs of waning glaciation. Erratic granitic blocks of enormous size were found on the flanks of Mt. Erebus, while in 85° S., on the summit of Mt. Hope, 3,350 feet above the sea and 2,000 feet above the surface of the adjacent glacier, was strewn with erratic blocks.

Murray believes that during the period of recent maximum glaciation the ice-cap had a thickness of four thousand feet in parts of McMurdo Sound, now ice-free.

It is thus evident that in the period of maximum glaciation there existed very extensive oceanic ice-caps, which projected seaward far beyond the continental shelf. Even in late years these ice-caps were sufficiently projected to furnish tabular icebergs or snowbergs of enormous thickness and vast extent, though they appear to have been more numerous from fifty to eighty years since than to-day. The present detachments are yet enormous, and Shackleton's southern party heard the noise and felt the ice-vibrations attendant on the breaking-away of the sea-front of the barrier while fifty miles distant.

Three examples of oceanic ice-caps, or barriers, yet remain: Drygalski Barrier, 200 feet elevation, fifty miles by twelve in surface, which projects 30 miles seaward with three fourths afloat; Nordenskiöld Barrier, of fifty feet elevation, twenty by five miles in surface,

entirely detached from the inland ice and afloat. Finally, the Great Barrier, of yet unknown extent, discovered by Sir J. C. Ross in 1841.

Shackleton's discoveries add very materially to the known area of the wonderful Great Barrier. The northern front of this oceanic ice-cap, which formerly extended at least one sixth around the globe on the 76th parallel, now covers forty-two degrees of longitude near the 78th parallel, a sea-frontage of about 470 statute miles. Its known projection seaward exceeds 400 statute miles, as its landward origin was determined by Shackleton to be south of 83° 30′ S., while its surface is in 77° 45′ S. He estimates its average elevation at 150 feet, and it seems most probable that the Barrier is afloat through the greater part, if not all, of its known extent. It is doubtless an under-estimate to place the superficial area of the Great Barrier at 200,000 square miles.

Formed as are all ice-caps of névé, the Great Barrier is peculiar in that it has not been subjected to great vertical pressures, and consequently has a low specific gravity, as is proved inferentially from a detached tabular snowberg which grounded in water about half its depth or thickness.

While the Great Barrier is fed only to a very slight degree by the inflowing glaciers, yet its movement seaward is doubtless due to some degree to the impulse given by enormous pressures from the great incoming glaciers of adjacent lands, especially from the mountains of South Victoria Land. For instance there must be a pressure of incalculable but vastly enormous power from Beardmore glacier, which has a surface area of over five thousand square miles, an average thickness of possibly a thousand feet, and necessarily a great velocity of movement due to its average fall of sixty feet to a mile throughout its length of one hundred miles. Some idea of this force may be gathered from the fact that it "raises pressure ridges on the Barrier for twenty miles out from its junction therewith."

The rate of superficial increase of the Barrier from local snowfall, and its rate of seaward movement are approximately known through a depot of provisions made on the ice in 1902 and uncovered six years and four months later. There had been an increase of 98 inches of snow, an average of 15 inches of unmelted snow annually, and an average annual movement seaward of "a little over 500 yards a year," about three tenths of a mile.

It would appear that the portion of the barrier farthest from the sea (over 400 miles) might be twelve hundred years in reaching the open ocean, and could then have acquired a thickness of 1,500 feet, provided it was wasted with normal rapidity. Ross in 1841 and Shackleton in 1908 observed portions of the sea-front where the cliffs rose 250 feet above the open ocean.

It is apparent that the sea-face of the barrier is steadily and rapidly disintegrating, as it has receded more than thirty miles since 1841.

The suggestion that "a great deal of (the inflowing glacier ice) may be thawed off from below by the sea-water" can not be accepted as undoubtedly the ocean has a uniform temperature of about 28°. Repeated observations for about three years by the Lady Franklin Bay expedition in the Arctic regions proved that the immersed portions of ice-floes of the northern seas, being fresh-water ice of land origin, are preserved indefinitely.

Glaciers.—Space fails in which to consider at length the many interesting observations on Antarctic glaciers visited and discovered. The two floating piedmont glaciers, Nordenskiöld and Drygalski barriers, have been elsewhere mentioned. The former is believed to be "moving actively from inland seawards," and there were 660 fathoms of water along its fifty-foot sea-face eighteen miles from shore.

The largest known ice-river of the world is the Beardmore Glacier, situated between 83° 33′ and 85° S., discovered and traversed by Shackleton and his Southern party. It is equally wonderful in its extent, its environment and its rapid movement.

One hundred miles in length and fifty in width, its surface area approximates 5,000 square miles. Through a glacial valley shut in between lofty sandstone mountains, the glacier falls 6,000 feet in its course of 100

miles, and is the only visible outflow from a vast unknown expanse of the south-polar ice-cap. Confined to a certain extent by lofty mountains and forced into a tortuous route, it is scarred by countless ridges and broken by thousands of crevasses. Receiving at its head enormous masses of névé it transforms them by the well-known processes of compression and expansion, of melting and regelation into glacial ice of the hardest, densest quality, and in most varied forms.

Of the surface conditions Shackleton records:

> Sharp blue-edged ice, full of chasms and crevasses, rising to hills and descending to gullies. . . . One crevasse (where Marshall fell through and was saved by his harness) open from the top, with no bottom to be seen . . . a drop of at least 1,000 feet. . . . In another, the last pony dropped out of sight, the broken swingle-tree saving Wild. . . . We marched 9 miles over a surface where many times a slip meant death. . . . Followed the bed of an ancient moraine, full of holes through which boulders have melted down.
>
> [Of the country] the wonderful scenery, the marvelous rocks. . . . A wonderful view of the mountains, with new peaks. . . . [In 84° 10′ S.]
>
> The main rocks of the mountain under which we are camped . . . the erratics of marble conglomerate and breccia are beautiful, showing wonderful colors, . . . a wonderful sight as [the mountain] towers above us with the snow clinging to its sides. . . . [In 84° 54′ S.] Rock mainly sandstone with six seams of coal.

Fitting surroundings these for such an ice-river—issuing from the highest plateau of the world.

To crown the scientific observation is the very brief medical report which records that there was no case of scurvy or other sickness, apart from temporary sufferings of the half-starved southern party on its return.

PHYSIOGRAPHY.—From a broad standpoint the southward extension of South Victoria Land, the discovery of eight mountain ranges and scores of peaks, the reaching of the vast ice-clad plateau and the locating of the south geographic pole on tableland approximately 12,000 feet in elevation, may be considered as the most important of the scientific labors of the expedition.

The southern journey disclosed the continuity of Antarctica for about 1,250 miles due north and south, from Cape North to Shackleton's farthest. It thus establishes beyond peradventure the actual existence of a southern continent as announced by Wilkes in 1840, and as conjecturally charted by Sir John Murray in about 1875.

Moreover, the many ranges of lofty mountains, with the extent and great elevation of the wonderful south-polar tableland, clearly classify Antarctica as the most remarkable of continents not only in its conditions of glaciation but also in its surpassing elevation. Well-considered calculation places, with a possible error of ± 200 meters, the mean elevation of Antarctica at 2,000 meters, more than twice the average elevation of Asia.

Not only is it of scientific interest that the great, almost landless Arctic Ocean is opposite the enormous uplifted mountainous Antarctica, but the mass and location of this vast southern continent, one and a half times greater in surface than Europe, should serve to solve or elucidate vexed problems of latitude-variations and pole-shiftings. If not a practical factor for the far future these conditions may well have been so during past ages, when a milder climate, abundant animal life, luxuriant vegetation and forestal growths obtained in the vicinity of the present north and south geographical poles.

REGION OF WILKES LAND.—Of geographic importance is Shackleton's discovery on his return voyage of an extension of the north coast of South Victoria Land some 45 miles to the westward. This ice-bound mountainous coast connects in all probability with the land of Wilkes, whose priority of discovery has been lately put beyond question by Admiral Pillsbury, U.S.N.

GENERAL RESULTS.—Briefly summarized the most important scientific results of Shackleton's expedition are:

1. Culminating data establishing the existence of an Antarctic continent.

2. The definite location of the south magnetic pole.

3. The existence of a continental mass twice greater in elevation than any other continent.

4. Geological data showing the structure of Antarctica.

5. Evidences of a former mild climate and extensive vegetation in the vicinity of the pole.

6. Meteorological data elucidating the atmospheric circulation of the southern hemisphere.

7. The highest tableland of the world, with the location of the south geographic pole on an unbroken ice-cap.

It thus appears that Shackleton has solved the difficult problem of equally satisfying by his expedition the demands of science and the expectations of the public.

A. W. Greely

U. S. Army

SPECIAL ARTICLES

PREDICTION OF RELATIONSHIPS AMONG SOME PARASITIC FUNGI

A flowering plant which would produce two separate and dissimilar sorts of fruit would indeed be a curiosity, and yet there are some of the common parasitic fungi which exhibit two, three and even four kinds of fruiting bodies or spores. In addition to the variability displayed by many species of fungi in the production of different sorts of spores, a large number of the rust-fungi present a still greater complexity of existence by having the life-cycle divided into two distinct alternating phases, which inhabit wholly different and unlike host plants, such as a sedge and a composite, or a broad-leaved deciduous tree and an evergreen.

In these species which are known to change hosts and on that account are termed heteræcious, the one phase consists usually of æcia, accompanied by one other spore-structure, the pycnium, and the other phase of telia, either alone, or accompanied by uredinia.

The combination in one species of these pleomorphic and heteræcious characters may make the working out of the life-history a very difficult problem. The connection or relation between two alternating phases is best shown by means of cultures. A culture in which a spore from one phase on one host is sown upon another host, and subsequently gives rise to a spore-form of the alternating phase, is the only conclusive evidence that the two phases are related and merely represent different forms of the same parasite. Cultures, therefore, must play an important rôle in the study and investigation of the rust-fungi, especially of those forms which are not only pleomorphic but also heteræcious.

In order that the culture work may be carried on in an expeditious manner, entailing as small an amount of unprofitable labor as possible, it is essential that the experimenter should be guided by some ideas of probable relationships between alternating phases. It often happens that there is nothing in the form or habit of either fungus or host which will give the slightest hint regarding the alternate host. In such instances a notion of relations can be gained only by field observations. The finding of spore-structures of two alternating phases in close proximity in the field is usually the only obtainable factor indicative of a connection between them. This is the case with many of the species of the genera *Puccinia* and *Uromyces*, the common rusts of grasses and sedges. The association of telial and æcial stages is, to be sure, not proof of their affinity, but only a bit of prima facie evidence. The closeness of the association, the abundance of the infection, and the occurrence of stages of other species must all be taken into account. A great deal has already been written[1] emphasizing the value of these observations of association in the field and it seems unnecessary to make further explanation here, suffice it to say that this method of gaining clues to relationships is largely a deductive one. From the fact that related alternating phases are often found associated together, we infer that other associated phases may be related. Association, in

[1] See "Clues to Relationship among Heteræcious Rusts," *Bot. Gaz.*, **33**: 62–66, 1902, and "A Search for Rusts in Colorado," *Plant World*, **11**: 69–77, 1908.

other words, might be considered a general law among heterœcious forms.

In addition to this deductive method, which requires field observations upon which to base its inferences, there is another method by which predictions of relationship may sometimes be inductively made. In some instances there is something peculiar about either host or fungus, or both, which will permit the formation of an hypothesis. These peculiarities may be in form, habit, range or other characteristics, and are usually of such a nature that they may be studied out in the herbarium or laboratory. This second method deals very largely with the principles of analogy and homology.

It is the analogical method of inferring that what is true of one species is probably true of others similar to it which makes us conclude, for instance, that the species of *Coleosporium,* common rusts of the composites especially, are related to leaf-inhabiting forms of *Peridermium* on pine trees, that the species of *Cronartium* are connected to bark-inhabiting forms of *Peridermium* on pine trees, and that the *Gymnosporangia,* the cedar-rusts, have *Rœsteliæ* on members of the apple family as their æcial forms. This general theory for the assignment of certain form-species to their telial genus has already been illustrated in a paper of which the writer was junior author,[2] and subsequent culture work has demonstrated not only the accuracy of the predictions, but also the importance of such theorizing.

The writer wishes now to call attention to still better examples of the application of this analogical process. Perhaps the procedure may be made clearer by a fuller statement of the formula and the consideration of some concrete examples. The examples will be drawn from the group of cedar-apple fungi, *Gymnosporangia,* because of the writer's familiarity with this group.

Analogy has been explained in this way: Two things which are similar in one or more respects are of the same general type or character; therefore a certain proposition which is true of one is likely to be true of the other. In applying this to the fungi, as well as in other cases, it is especially important that the characters selected for comparison should be fundamental ones and not merely of a superficial nature. Some accumulated knowledge in a field, even if it should only be in the form of negative answers to previous conjectures, may not be without value in forming new hypotheses.

The following example may be cited in which cultures have already shown the correctness of an hypothesis formed by the method just explained.

Some time ago what appeared to be a true *Rœstelia* was found upon an herbaceous plant of the rose family. This was considered remarkable because it had always been supposed that all *Rœsteliæ* inhabited only woody plants of the apple family. Upon thorough examination, however, this was found to have all of the morphological characters of the rœstelial forms and it was, therefore, concluded that it was most likely associated with a cedar-rust, as other members of this form-genus are. There was in the range no unattached species of *Gymnosporangium* known which might have such a connection; this discovery called, therefore, for the detection of a new form. From the great resemblance of this rosaceous *Rœstelia* to the æcial form of *Gymnosporangium Nidus-avis,* a rather common and well-known cedar rust, it was predicted that the telial stage, when found, would resemble *G. Nidus-avis.* This new telial stage has been collected and cultures have been made proving the correctness of the assumption as to relationship. The prediction as to structure was also strikingly fulfilled, showing that it is not only possible to show the probable existence of new forms by this method but even to anticipate their characters. This species has been named *Gymnosporangium exterum* and a fuller account of its discovery together with original description and culture record may be found in *Mycologia,* **1**: 226, 227, 253 and 254, 1909.

[2] See "North American Species of *Peridermium*," *Bull. Torrey Botan. Club,* **33**: 403–438, 1906.

The writer ventures to offer the following conjectures of relationship with the hope that cultures may some day prove their correctness. They may turn out eventually to show only the errors which the method of analogical inference may lead to, but they serve well to illustrate its application to this subject and are offered with the hope that they may have some value.

Rœstelia hyalina on a species of hawthorn, *Cratægus*, is a peculiar form which has been very little known up to the present. So far as the writer can make out there is no published record of any but the original collection from South Carolina made in 1860. The writer has recently rediscovered it on some herbarium specimens of the host plant at the New York Botanical Garden and the Arnold Arboretum so that its occurrence is after all not so rare; its distribution is now known from North Carolina to Florida. This adds new zest to the attempt to trace out its alternate phase. Morphologically *R. hyalina* has two very striking characters; first, the entirely smooth walls of the peridial cells, and second, the small wart-like protuberances on the leaves in which the peridia are borne. Only one other known species, *R. Botryapites* on *Amelanchier*, the service-berry, has these characters and it has seemed to the writer for some time that these two forms must be related to similar telial stages. *R. Botryapites* is known to be connected to *Gymnosporangium biseptatum* on the white cedar, *Chamæcyparis thyoides*. *G. Ellisii* is another white cedar rust, similar to *G. biseptatum* in the form of the distortion produced on the host and in the character of the spores, both having 2–4-celled teliospores. *G. Ellisii* has been supposed by some to be connected to *Rœstelia transformans* on *Aronia arbutifolia*, but a careful examination of the culture record shows that this conjecture has never been successfully demonstrated. On the other hand, there are so many negative results that it seems almost safe to conclude that it has been disproved. It seems very probable that since one of these two forms of *Rœstelia*, forms which are in a class by themselves on account of their smooth peridial cells and external anatomy, belongs to a white cedar rust of a certain type, that the other may belong to the only other white cedar rust of the same general type at present known. Recent collections of *G. Ellisii* by Stone in Alabama and Tracy in Florida make its known range from Massachusetts to Alabama so that it is quite feasible to suppose it connected with a form which is known in the heart of that range, North Carolina to Florida.

If an hypothesis provisionally formed either by association or analogy can be supplemented by inferences drawn from homology it is very materially strengthened. Homology might be defined so far as its application to botany is concerned as the morphological likeness existing between elements which may have become adapted to quite different functions. In applying this to the subject under discussion, for instance, if there is an essential structural resemblance between the æciospores and the urediniospores of a species they may be said to be homologous. Some notable examples in which homology in this sense has assisted in detecting genetic relationships have already been recorded by Dr. J. C. Arthur in his first report of "Cultures of Uredineæ"[3] and may be mentioned here.

Field observations had suggested that *Puccinia Vilfæ* on a grass, *Sporobolus longifolius*, was related to *Æcidium verbenicola* on *Verbena*. It was found that the closer the *Verbena* plants stood to tufts of the rusted grass the more thickly they were covered with æcia, and that the plants some distance away were entirely free. This is a good example of the working of the law of association. Before cultures were made, however, a resemblance in form was observed between the æciospores of *Æcidium verbenicola* and the urediniospores of *Puccinia Vilfæ*. The two sorts of spores were similar in shape and surface markings, and both had colorless walls much thickened at the apex. Later successful cultures proved that this homology was not a mere accident in this case and suggested that it might be the sign of relationship in other instances. During the same year a similar morphological correspondence was found between the æciospores of an *Æcidium* on *Fraxinus*, the ash tree, and the urediniospores of a *Puccinia* on *Spartina*, cord-grass, and with this as the only clue cultures were attempted. They were successful and thus

[3] "Cultures of Uredineæ in 1899," *Bot. Gaz.*, **29**: 274–275, 1900.

showed the value of inferences drawn from homology.

The writer now desires to make one other prediction concerning a possible relationship, and the character of a form yet to be discovered, in which both analogy and homology have been employed.

In his paper on "Cultures of Uredinæ" in 1908 Dr. J. C. Arthur reports the establishment of a relationship between *Æcidium Blasdaleanum* and *Gymnosporangium Libocedri*. As explained there *A. Blasdaleanum* is morphologically unlike the other *Rœsteliæ*, having instead, characters like the ordinary æcial forms of *Puccinia* and *Uromyces*. However, it inhabits hosts belonging to the apple family, the hawthorn and service-berry, and these cultures show that it is undoubtedly genetically connected with a cedar-rust. There is, in the Pacific coast region, another æcial form of the same type, on members of the apple family, *Æcidium Sorbi* on the mountain ash and crab-apple. Although *Æcidium Sorbi* is of the same general type as *A. Blasdaleanum*, it has some very pronounced characters which show that it is specifically different. There is in the whole Pacific slope region at present no known *Gymnosporangium* except *G. Libocedri* and it is at once apparent that the telial stage of *A. Sorbi* is still to be discovered. There is, however, within this range a cedar-rust in the form of *Uredo Nootkatensis* on *Chamæcyparis Nootkatensis*, the yellow cedar, from Alaska. That *Uredo Nootkatensis* is the uredinial stage of a *Gymnosporangium*, which has in its life-cycle an æcial stage on hosts belonging to the apple family, has been previously suggested.[4] The basis for such an argument has been furnished by the elucidating researches of Dr. Arthur of which his new classification[5] of the Uredinales is the result. From this work it appears justifiable to assume that the production of all four spore-forms, pycnia, æcia, uredinia and telia, was doubtless the early condition in evolution, and that the suppression of one or more of these forms is a result of later influences. In most of the groups or tribes this four-spored condition not only still persists but usually the larger number of species belong in that class. Arguing from this point of view Dr. Arthur has predicted that sooner or later a *Gymnosporangium* ought to be discovered which would possess uredinia, *i. e.*, have all four spore-forms. Since the uredinial stage is unknown in any of the true *Gymnosporangium-Rœstelia* combinations it seems probable that if it exists at all it is likely to be in a species which has an æcial form like that of the species of *Puccinia* which ordinarily possess uredinia. With the above ideas as a basis the writer suggests the possibility of a relationship between the cedar-rust, *Uredo Nootkatensis* and *Æcidium Sorbi* on the mountain ash and crab-apple. Baranoff Island, Alaska, is the type locality of the *Uredo; Æcidium Sorbi* has also been collected on the same island, an item from geographical distribution which lends further support to the supposition. Arguing from a comparison with *G. Libocedri*, the only cedar-rust known to have the puccinia-type of æcia, the new telial stage should be foliicolous and have spores two or three times septate. If the above contention is true it may well be asked why *G. Libocedri* should not have a uredinial stage if there is anything in analogy. The answer is that it probably does but that it is unknown because no well-directed attempt has yet been made to collect it.

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[4] *Bull. Torrey Botan. Club*, 35: 501–502, 1908.

[5] "Eine auf die Structur und Entwicklungsgeschichte begrundete Klassifikation der Uredineen," *Résult. Sci. Congr. Bot. Vienne*, 331–348, 1906, and "Reasons for Desiring a better Classification of the Uredinales," *Jour. Myc.*, 12: 149–154, 1906.

THE MIOCENE HORIZONS AT PORTERS LANDING, GEORGIA[1]

THE following section of the exposure at Porters Landing is adapted from the description of it given by Mr. Earle Sloan in his "Catalogue of the Mineral Localities of South Carolina," page 273.

[1] Published by permission of the Director of the United States Geological Survey.

	Feet
6. Pleistocene—white, red and yellow sands, with phosphatic pebbles and vertebrate fragments at the base	64
5. Miocene—compact, yellow, fossiliferous marl (Duplin horizon)	6
4. Miocene—grayish, fossiliferous marl (Marks Head marl)	29
3. Fine-grained, laminated shale with sandy partings, a line of rounded pebbles at the base	14
2. Oligocene—fossiliferous marl (Alum Bluff formation)	½
1. Laminated, drab shale with arenaceous partings	8
Total	111½

Recent collections made at Porters Landing have rendered possible definite correlation of the two Miocene horizons with those of the areas further north. From bed no. 5 of the section 34 identified species were obtained, 30 of which also occur in the Duplin marl of North Carolina. The four species which have not as yet been reported from there occur in other localities in horizons the stratigraphic equivalent of the Duplin, or in deposits of later age. Bed no. 5, therefore, can be definitely correlated with the Duplin marl of North Carolina and the fossiliferous Miocene marls of Darlington and Mayesville, South Carolina.

The Marks Head marl, which was first named by Sloan, and is represented by bed No. 4 of the section, contains specimens of the genus *Carolia* which suggests an Oligocene age, but every other identifiable species may be Miocene, and only three of them range downward into the Oligocene. Nine of the species are not known below the Miocene, and of these nine, six are confined to the Miocene. The horizon is, therefore, Miocene, while the presence of *Turritella æquistriata* Conrad, *Calliostoma aphelium* Dall, *Ostrea mauricensis* Gabb, and *Pecten marylandicus* Wagner, definitely point to a horizon low in the series, approximately equivalent to the Calvert formation of Maryland.

The recognition of the stratigraphic position of this horizon is of importance, as it is the only low Miocene horizon known south of Virginia. Further south in Florida, along the western extension, on the Ocklockonee and Apalachicola rivers, the Miocene rests upon the eroded surface of the upper Oligocene. The Miocene deposits of these localities represent a horizon high in the series. Therefore, the Marks Head Miocene is the equivalent in part to the erosion interval between the upper Oligocene and the Miocene of western Florida.

Bed no. 2 of the section at Porters Landing contains fossils indicative of an upper Oligocene age. Bed no. 3 is very likely of Miocene age, and the line of rounded pebbles at the base suggests that the Miocene may rest upon the eroded surface of the upper Oligocene. It seems probable that along the Savannah River an erosion interval occurred between Oligocene and Miocene depositions, but the interval was of shorter duration than in western Florida.

T. Wayland Vaughan

THE AMERICAN SOCIETY OF ZOOLOGISTS CENTRAL BRANCH

The annual meeting of the American Society of Zoologists, Central Branch, was held in the splendid new Natural Science Hall of the University of Iowa, Iowa City, on April 7, 8 and 9, 1910, Dean Edward A. Birge, of the University of Wisconsin, presiding. Thirty zoologists of the central states registered.

Resolutions relating to the International Commission on Nomenclature similar to those adopted by the Eastern Branch at the December meeting were passed, and the following zoologists were appointed as a committee to cooperate with the International Commission: C. C. Nutting, C. H. Eigenmann, C. A. Kofoid, H. B. Ward, S. W. Williston.

Officers for the ensuing year were chosen as follows:

President—C. E. McClung, University of Kansas.

Vice-president—H. F. Nachtrieb, University of Minnesota.

Secretary-Treasurer—H. V. Neal, Knox College.

Executive Committee—R. H. Walcott, University of Nebraska, W. C. Curtis, University of Missouri, Oscar Riddle, University of Chicago.

The following, having received the votes of the

executive committees of both branches were elected to membership in the Central Branch: J. T. Patterson, University of Texas; Robert T. Young, University of North Dakota; John W. Scott, Kansas City High School; F. D. Barker, University of Nebraska; Albert Kuntz, University of Iowa; Chancey Juday, Wisconsin Geological and Natural History Survey; H. W. Norris, Grinnell College.

The following are titles and abstracts of papers presented at the meeting:

Some Personal Peculiarities of Lakes (president's address): EDW. A. BIRGE, University of Wisconsin.

The paper dealt with certain unusual, but regularly recurrent phenomena in the temperature, dissolved gases and carbonates of several inland lakes, and with the biological meaning of such phenomena. On the annual rhythm of physico-chemical changes in a lake, produced by the march of the seasons, there is superimposed another annual series of similar changes, due to biological causes. These last are in large measure regular and determined by general laws; but in part, and especially in their details, are peculiar and "personal" to the several lakes. They result from the establishment of habitual interactions between the members of the plankton and between plankton and environment.

Inland lakes contain a complex and practically closed assemblage of plants and animals, which have lived together for centuries, in an environment substantially unaltered from year to year and whose exchanges with the outer world are minimal. Thus the lake with its plankton has come to be a sort of organism of a higher order, showing definite and regular internal changes and reactions not unlike those of an organism—changes not so definitely expressed or so definitely dependent on biological causes in any other assemblages of organisms. In certain lakes we find habitual reactions, unexpected *a priori*, and in this respect not unlike reactions of higher organisms.

Inland lakes, therefore, offer to the student definite and varied ecological problems of much interest and complexity. These concern the relation to each other of members of the plankton, the effects of plankton on environment and the resulting influence on plankton of environmental changes. Such problems are by no means wholly general, to be solved by the study of a single lake, but they offer many features which are special and personal to individual lakes.

Feeding Reactions of the Rose Coral (Isophyllia): F. W. CARPENTER, University of Illinois.

When the rose coral polyp is stimulated by meat juice the oral disk is drawn downward by the contraction of the retractor muscles of the mesenteries, and the margin of the oral surface is folded inward over the disk by the action of a well-developed sphincter muscle. Meanwhile, the stomodæum is everted, and the mesenterial filaments are extruded both through the mouth and through temporary apertures in the oral disk. Carmine particles dropped on the oral surface of an expanded polyp are transferred by ciliary action to the periphery. When the carmine grams have previously been soaked in meat juice the cilia usually continue to beat in an outward direction; occasionally, however, they reverse their effective strokes. The tentacles react quickly to contact stimulation, and affix the touching object to their knob-like distal ends, which are heavily loaded with nematocysts.

In normal feeding, which occurs after dark, small organisms in the plankton are affixed by the tentacles, the oral disk sinks, and the marginal zone of the polyp folds inward until it completely roofs over the tentacles and the depressed oral disk. Into the superficial chamber thus formed the stomodæum and mesenterial filaments project, and here the mesenterial filaments, which are the digestive organs of the polyp, probably digest and ingest or absorb the captured plankton, little of which finds its way into the reduced gastro-cœlomic cavity. Extra-cœlenteric digestion appears, therefore, to take place in rose coral polyps.

The Factors which Control the Leaping of the Pacific Salmon: HENRY B. WARD, University of Illinois.

Open water jumping was observed best among salmon swimming about in a pound net or trap. The same fish does not execute a series of leaps, but only a single jump. Features in the position and movements of body and fins show that it is neither an effort to escape capture nor preparation for the ascent of the stream later. It must be regarded as a type of play which, however, finds expression only as the reproductive period approaches. It occurs first at the time when the reproductive organs are entering upon their final growth period.

Jumping at falls manifests in several particulars of position and movements of body and fins a definite relation to the purpose of surmounting the obstacle. In a large per cent. of cases the

effort is unsuccessful and displays apparent lack of accuracy in direction as well as distance of height. Since the fish jump for the most part in parallel lines perpendicular to the face of the fall, one would expect to find some definite disturbing influence to explain the apparently erratic leaps. Such an influence is present in the confused water currents at the base of the fall. The sudden and irregular changes in the whirlpools and swirls where the fish lie waiting for an opportunity to jump no doubt act to modify the direction of the leap and cause the fish at times to execute apparently aimless jumps. The jumping was most regular at the point where the current was most constant.

Reproduction and Parasitism in the Unionidæ: George Lefevre and W. C. Curtis, University of Missouri.

Further Experiments on the Egg-laying Habits of Amphitrite: John W. Scott, Kansas City High School.

Experiments on the Control of Asymmetry in the Development of the Serpulid, Hydroides dianthus: Charles Zeleny, University of Illinois.

A Statistical Study of the Sex-cells in the Early Stages of Amia and Lepidosteus: B. M. Allen, University of Wisconsin.

Function of the Spermatozoon in Fertilization, from Observations on Nereis: Frank R. Lillie, University of Chicago.

The author succeeded in destroying the sperm nucleus within the egg at stages as much as twenty minutes apart shortly after the time of its entrance, and found that while such eggs, which had formed the fertilization membrane and started in development, continued until the formation of the second polar body, they did not form a complete cleavage spindle and the egg remained unsegmented. The female pronucleus of such eggs formed the chromosomes but no definite segmentation spindle, and asters were practically absent. This was true even when one of the maturation divisions had formed the polar nucleus inside the egg, as sometimes happened, so that the quantity of maternal chromatin equaled that of the fertilized egg. It follows, therefore, that fertilization is incomplete for some time after the entrance of the spermatozoon into the egg, in the case of *Nereis*, and that its completion is not merely a quantitative chromatin factor.

The result was obtained by centrifuging eggs at regular intervals from the moment of fertilization on. There was found a certain period soon after the entrance of the spermatozoon when the mechanical shock destroyed the sperm nucleus in large proportions of the eggs. This was determined by a cytological study of these eggs and their controls in the maturation and fertilization stages. The percentage of eggs thus studied and found to be devoid of a sperm nucleus corresponded quite accurately with the percentage of eggs observed to remain unsegmented in the living eggs of the same series. At the critical stage selected for comparison, the determination of the presence or absence of the sperm nucleus is a simple matter. Stimulation of the unfertilized egg with potassium chloride, or a mechanical shock, will suffice to cause the formation of the fertilization membrane and of the polar bodies, thus producing exactly the same effect as the first penetration of the spermatozoon, and no more, for these eggs also did not segment.

Fertilization can not, therefore, be regarded as exclusively a surface phenomenon. It must be interpreted as, in some sense, a continuous process, lasting for some time after the penetration of the spermatozoon, possibly until the union of the germ nuclei. As one of the first effects of penetration is demonstrably increase of permeability, it may be that the later function of the spermatozoon is essentially similar throughout the entire thickness of the protoplasm, by overcoming, so to speak, a certain resistance to permeability in successive strata and creating a consequent free oxidation in the interior of the egg. The mass of the egg cell is obviously in excess of the functional optimum for oxidation, and increased permeability of only the surface would hardly be expected to bring about free oxidation throughout the whole.

It is practically certain that the destruction of the sperm nucleus by centrifuging did not mean its expulsion from the egg in these experiments, but merely suppression of its power of growth, or dissipation of its substance. Its material remains within the egg; but, existing only as so much chemical matter, it does not exercise a fertilizing effect. Its fertilizing power is in some way bound up with its organization and growth.

The Chromosomes of Anasa tristis: C. E. McClung, University of Kansas.

Generic Definitions: C. C. Nutting, University of Iowa.

Some Parasites of the Sleeper Shark in Icy Straits, Alaska: Henry B. Ward, University of Illinois.

Somniosus microcephalus Le Seur is common in Icy Straits. Its range extends through the Arctic waters to the North Atlantic. Specimens examined in Europe are regularly infested with a gill parasite, *Squalonchocotyle borealis*. This ectoparasitic trematode undergoes, no doubt, direct development. It occurs abundantly on Alaskan specimens of the same host. Four other internal parasites are recorded from this host in the Atlantic. These undergo probably indirect development and hence need one or more intermediate hosts. The sleeper shark in Alaska harbors species from the same genera as those in the Atlantic, but they are related rather than identical parasites. As in the case of land animals, so in this marine host, the species of parasites which infest it vary in different portions of its range.

Some New Cases of Trihedral Tænia: F. D. BARKER, University of Nebraska.

The examination of 37 dogs at the University of Nebraska from November, 1903, to April, 1910, yielded 601 *Tænia serrata* and 450 *Tænia serialis* in addition to a large number of other species of *Tæniæ*. Among the *T. serrata* were four trihedral or prismatic tæniæ and among the *T. serialis* were three trihedral forms. This increases the number of reported trihedral tæniæ to thirty cases and adds two new species to the list. The specimens resemble two tapeworms, the one fused along its side to the face of the other. Each scolex has six suckers arranged in three groups of two each. The rostella are armed with two rows of hooks, but the number of hooks in each row is less than the normal. One or two genital pores occur in each mature proglottid, one pore to a crest. The trihedral condition affects the musculature, the nerve trunks, the excretory canals and the reproductive organs. The onchospheres have six to twelve hooks.

These trihedral forms probably arise from a double embryo produced by the partial separation of the first two or early blastomeres and not by a fusion of two normal embryos.

A Comparative Study of the Development of the Sympathetic Nervous System in Birds and Mammals: ALBERT KUNTZ, University of Iowa.

Medullary cells migrate from the neural tube into the ventral nerve-roots. With similar cells which wander out from the spinal ganglia, these cells migrate peripherally along the spinal nerves. Some of these cells deviate from the course of the spinal nerves and give rise to the sympathetic trunks and the prevertebral plexuses. The vagal sympathetic plexuses, viz., the cardiac plexus and the sympathetic plexuses in the walls of the visceral organs, arise from cells which migrate from the hind-brain and the vagus ganglia along the vagi.

The great majority of the cells which migrate peripherally from the neural tube and the cerebrospinal ganglia are the "indifferent" cells of Schaper. Among these are found a few "neuroblasts" of Schaper. Therefore, the sympathetic neurones are homologous with the efferent and the afferent components of the other functional divisions of the peripheral nervous system. Mitotic figures occur occasionally along the course of migration and in the sympathetic anlagen. We are not to suppose, therefore, that all the cells taking part in the development of the sympathetic system actually migrate as such from their sources in the cerebrospinal system. Doubtless, a goodly number arises by the mitotic division of "indifferent" cells along the course of migration.

Certain morphogenetic differences occur in the development of the sympathetic system in birds and mammals which, doubtless, indicate that the sympathetic system has departed more widely from the original type in birds than in mammals.

The sympathetic system may be looked upon as an accession to the nervous system which has arisen comparatively late in the evolution of vertebrates in response to the conditions of the vegetative life.

The Histology of the Nasal Mucous Membrane in Mammals: WM. A. LOCY, Northwestern University.

An illustrated account of the structure and of the histogenesis of the nervous elements in the sensory epithelium of the nose of the pig and rabbit with some remarks on the question of the direction of growth of nerve fiber.

The Lymphatic System of Turtles: FRANK A. STROMSTEN, University of Iowa.

The points considered in this paper were the anatomy of the lymphatic system of *Chrysemys marginata* and the development of the lymph hearts of the loggerhead turtle. A preliminary paper with figures giving the results of this investigation is to be published at once elsewhere.

The Bermuda Biological Station for Research: F. W. CARPENTER, University of Illinois.

The Work of the Illinois Biological Station: STEPHEN A. FORBES, director, Illinois State Laboratory of Natural History.

This station differs from most American fresh-water stations, in the fact that its equipment is all afloat, and readily movable from place to place; that it is devoted to investigation only, and not to teaching; that it is in operation throughout the year instead of being limited to the vacation season; that it is devoted to a study of the biology of a river system instead of a lake; and that it is supported directly by appropriations from the treasury of the state.

Opened in April, 1894, it remained at Havana, Ill., for five years; was then transferred forty-five miles down the Illinois to Meredosia, where it continued for two years and two months; thence up the Illinois a hundred and sixty-five miles to Ottawa, where it remained for a year and a half; and then to Henry, forty miles below. Here it was laid up to permit the preparation and publication of papers and reports setting forth the main results of its work; but it became active again, at Havana, July 1, 1909.

During the first two years its field work was comprehensive of all aquatic forms and situations, the next three years were devoted mainly to plankton work in the Havana district, and the following four to work on the fishes of the Illinois system. Of the 6,000 collections made during this period, about 500 were fishes, 2,000 were plankton collections, and 3,500 contained a general variety of aquatic and subaquatic forms. Six hundred and forty of the plankton collections were made at Havana by strictly quantitative methods, and are available for a comparative study of the product of various waters at all times of several successive years. Weekly samples of the waters were examined by chemical methods for three and a half years. Besides these local studies, steamboat trips were made for considerable distances, with continuous plankton collections throughout each trip. Longitudinal biological sections of the stream were thus made, aggregating four hundred and fifty miles on the Illinois River and three hundred and sixteen miles on the Mississippi between St. Louis and Quincy.

The main object of the station operations for the coming two or three years will be to complete a comparison of present conditions with those of the former time; to study the river as a unit with special reference to its economic and hygienic protection and improvement; to work out the details of its biological regimen, by a separate study of special problems; and to carry on comparative studies between the Illinois, the Mississippi and the Missouri, all readily accessible from the station field. Its most recent work has been directed to a comparison of present conditions with those before the opening of the Chicago drainage canal and to a collection of materials for further studies of the food of fishes, and for physical and chemical studies of the bottom in selected situations as related to differences in biological production. From weekly collections continuing for four months it appears that the plankton of the main stream is now approximately double the amount per cubic meter that it was before the opening of the drainage canal, notwithstanding the fact that the water averages about three feet higher than it did before that event.

The Indiana University Biological Station: Fernandus Payne, Indiana University.

Hydroids from the Illinois River: Frank Smith, University of Illinois.

A Report on the Fresh-water Protozoa of Tahiti: C. H. Edmondson, Washburn University.

Some New Species of Cretaceous Fish from Kansas: C. E. McClung, University of Kansas. (Read by title.)

Investigations on some Lakes in Guatemala and Salvador: Chancey Juday, University of Wisconsin.

Restoration of Cacops aspidephirus, a remarkable new rhachitomous Amphibian from the Texas Permian: S. W. Williston, University of Chicago. (Read by title.)

The Fairport Biological Station:[1] Robert E. Coker, director.

A biological station has been established by the United States Bureau of Fisheries at Fairport, Iowa. The immediate work of the station will be in the cultivation of fresh-water mussels, experiments and investigations relating to the propagation and natural history of the forms important in relation to the pearl button industry and the pearl fishery. The ultimate scope of the station is broad: it is expected as soon as possible to have all facilities of a station thoroughly equipped for the investigation of problems of fresh-water biology. During the present year operations will be conducted with a preliminary equipment, consisting of gasoline pumps, a series of small ponds with reservoir, and a temporary laboratory.

Are Muscle and Nerve primarily connected? H. V. Neal, Knox College.

[1] By permission of the United States Commissioner of Fisheries.

The "Plasmodesmata" of Held and Paton, connecting myotome and neural tube, are not primary intercellular bridges, but are secondary connections of medullary origin. The "neurofibrillæ" are intracellular differentiations of the neuraxon processes of medullary cells. The methods used in the study of the histogenesis of the neurofibrillæ do not seem suited to the study of the development of the "plasmodesmata."

The Teaching of Zoology and some Suggestions for its Improvement: W. J. BAUMGARTNER, University of Kansas.

The paper showed that many more students take botany than zoology in the secondary schools. Some reasons were cited for this. Universities can help the teaching of zoology by furnishing some material. The teaching of zoology can be improved by assigning the student a special animal to report on to the rest of the class.

Cestode Cytology: R. T. YOUNG, University of North Dakota.

Both in larva and adult new nuclei in many cases arise *de novo* in masses of cytogenic protoplasm. The evidence of this is the appearance of small, densely staining chromatin bodies in these masses. These later surround themselves with membranes (or the membrane may arise first and the chromatin body later) and are then constricted off from the cytogenic mass, together with a small amount of cytoplasm to form new "cells." Some nuclei are typical, consisting of membranes surrounding distinct chromatin nucleoli; while in others the entire "cell" body is filled with diffuse chromatin, as is shown by micro-chemical tests. A count of some 34,000 nuclei showed only fifty cases of possible mitosis. Amitotic division of preexistent nuclei also occurs. It is probable that mitosis is degenerating in the cestodes, corresponding to their general degenerate condition.

Fifty-one Generations in the Dark: F. PAYNE, Indiana University. (Read by title.)

DEMONSTRATIONS

Sections showing the Early Sex-cells of Amia and Lepidosteus: B. M. ALLEN.

Some Parasites of the Sleeper Shark: H. B. WARD.

Hydroids from the Illinois River: FRANK SMITH.

Sections showing the "Plasmodesmata" connecting Myotome and Neural Tube in Squalus: H. V. NEAL.

H. V. NEAL,
Secretary

KNOX COLLEGE

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 446th regular meeting of the Anthropological Society, held April 12, 1910, was devoted to the retirement address of the president, Dr. J. Walter Fewkes, on "Cave Dwellers of the Old and New World." The full text of this address will be published later.

The unity of the human mind, said the speaker, has come to be one of the most fruitful working hypotheses in the science of culture history. Identities in human culture, under similar climatic and other environmental influences are among the strongest evidences that can be adduced in support of this theory. As human habitations, the most characteristic of racial artefacts, reflect better than all others the effect of environment, the object of the address was to indicate the bearing of a comparative study of cave dwellings from different geographical localities on the theory of mental unity.

A people of nomadic life whose habitations from their mode of life are perishable has little stimulus to construct lasting monuments. Sedentary people, on the other hand, construct habitations of material that will endure; caves when available naturally first afforded shelter for races seeking permanent dwellings.

It is difficult to find a primitive race where human culture has reached any considerable architectural development that has not, at an early cultural period, lived in caves or holes in the ground. Life in caves leads to buildings made of stone or other lasting materials. Permanence of building perpetuates racial traditions, serving as constant incentives to the construction of architectural monuments.

A study of the distribution of prehistoric cave habitations reveals a marked uniformity of cave dwellings in regions of the earth geographically far apart. Prehistoric cave dwellings of similar form may be traced from China across Asia and on both shores of the Mediterranean, in Mexico, Peru and the southwestern part of the United States. This distribution corresponds in a measure with that of great prehistoric monuments and follows closely that of the arid regions.

Caves as habitations are divided into two types, natural and artificial. The address treated more particularly of the latter, but views of both from the old and new world were shown.

The European natural cave as a shelter is prehistoric, having been abandoned in very early times. The natural caves of Cuba, Hayti and

Porto Rico were, however, inhabited by primitive men of low culture and characteristic speech when America was discovered.

Artificial caves in the Verde Valley, Arizona, were shown to resemble those in Asia Minor, the Crimea, Caucasus Mountains and Canary Islands. Exact counterparts of the "tent rocks" or "cone dwellings" of the Otowi Canyon, in New Mexico, occur in Cappadocia near Cæsarea Mazaca. Views were shown illustrating the resemblances of certain cliff houses in Arizona, and monastic establishments in Thessaly. The speaker called attention to an inhabited subterranean village Matmata, in northern Africa, and underground habitations, now deserted, in volcanic cones near Flagstaff, Arizona. The resemblance in architecture of a Berber village in the Sahara to a Hopi pueblo, was incidentally considered.

Views were shown of oriental rock temples, the most striking of which were those of the rock city, Petra, in Syria, which was characterized as the most exceptional cliff ruin in the world.

The 447th regular meeting of the Anthropological Society, held April 26, 1910, was also its 31st annual meeting.

The meeting opened with reading of the minutes of last year's annual meeting. The secretary then read a report of the activities of the society during the last session which, briefly stated, was as follows: The society held fourteen meetings with an average attendance of 64 members and guests. At these meetings twenty papers were presented by sixteen contributors.

The president, Dr. J. Walter Fewkes, commemorated in a few appropriate words the members of the society who during last session departed this life, viz., Professor Enrico Gigiioli, of the Museum of Florence, Italy, who has been an honorary member, and Professor Simon Newcomb and Mr. W. C. Whittemore, active members.

The society then proceeded to the election of officers, which resulted as follows:

President—J. Walter Fewkes.

Vice-president—George R. Stetson.

Secretary—I. M. Casanowicz.

Treasurer—George C. Maynard.

Additional members of the Board of Managers (besides the former presidents of the society, who are *ex officio* permanent members of the board)—William H. Babcock, J. N. B. Hewitt, David Hutcheson, Edwin L. Morgan, John R. Swanton.

I. M. Casanowicz,
Secretary

THE MICHIGAN ACADEMY OF SCIENCE
SECTION OF ZOOLOGY

The regular meetings of the section were held March 31 and April 1, 1910, at the University of Michigan. The following papers were read:

"Notes on Michigan Reptiles and Amphibia, II.," A. G. Ruthven.

"Some New Light on the Development of Reptilia," E. C. Case.

"Variation in *Lymnæa reflexa* Say, from Huron County," H. Burrington Baker.

"The Crustacea of Michigan," A. S. Pearse.

"Preliminary Report on the Anatomy of *Physa gyrina* Say," H. Burrington Baker.

"Notes on the Distribution of the Unionidæ of North America," Bryant Walker.

"Regeneration in the Nerves of *Cambarus*," H. M. MacCurdy.

"A Contribution to the Theory of Binuclearity" (lantern slides), R. W. Hegner.

"The Origin and Meaning of the Second Polar Body," Chas. R. Barr.

"On Two Abnormalities in the Crayfish," Lucia Harmon.

"The Rotary Power of Extracts of the Bodies of Snails," Elliot R. Downing.

"The Formation of Habit at High Speed," O. C. Glaser.

"Notes on some of the Rarer Species of Michigan Birds," Walter B. Barrows.

"Methods of Photographing Birds" (lantern slides), R. W. Hegner.

"A Simple Cooling Device for Use with the Microtome," O. C. Glaser.

"A Word on Double Embryos," O. C. Glaser.

"The Theory of Mimicry" (lantern slides), Jacob Reighard.

"The Pearl Organs of American Minnows in their Relation to the Factors of Descent" (lantern slides), Jacob Reighard.

"Some Methods of Studying Vision in Fishes, with Demonstration of Apparatus," Crystal Thompson and Mary Axt.

"A Remedy for the Black Fly Pest in the Southern Peninsula of Michigan," Cora D. Reeves.

"Experiments on the Rôle Played by Odors in Determining the Behavior of Bees," Max Peet.

"Mimicry in *Tabanus atratus*," S. D. Niagers.

"The Mendelian Law Demonstrated by the Domestic Fowls," S. D. Magers.

R. W. Hegner,
Secretary

Ann Arbor, Mich.